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AND ABSTRACT OF THE LITERATURE

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German Literature on the White Lead Question, 1921

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THE JOURNAL OF INDUSTRIAL HYGIENE

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STUDIES ON UNDERNOURISHMENT IN INDUSTRY. I.*

WILLIAM HALL BUNN, M.D.

Youngstown Mazda Lamp Division, National Lamp Works of the General Electric Company

FROM time to time one sees reports of nutrition experiments which have been carried out in various public schools, and which prove beyond doubt that children will gain in weight if given extra nourishment between meals. Those who have had the opportunity of observing children on such a régime claim that there is also an increase in the ability of the child to progress in his school work, or, if you please, an increase in efficiency. The gain in weight is a fact easily proven, whereas the gain in efficiency is merely an opinion—for it cannot be accurately measured.

Believing that there is a definite relationship existing between physical par or, better, nutritive par and par efficiency, we set about to prove this in a modern factory employing 350 women, averaging 22 years in age. There are two reasons for believing that conclusions arrived at from this study will be more accurate than similar observations among schoolchildren would be: first, the factor of the growing individual is practically eliminated because of the physical maturity of the working woman; and, second, because the conditions of existence vary less from month to month—that is to say, there is less vacation, less travel, and less variety in diet among this class than is found in the life of the child of school age.

GROWTH OF THE IDEA

It may be of interest to know the manner in which the idea of making this study developed. In the early part of April, 1921, it was our privilege to hold "sick call" every noon in the dispensary of a plant employing several hundred persons, mostly girls. We were impressed by the number of workers showing evidence of malnutrition, and suggested that they be given intermediate nourishment. By way of experiment, therefore, several girls were each supplied with an 8-ounce glass of milk at 10 A.M. and at 3 P.M. After an absence of four months abroad, we were surprised, on our return, to find a very definite gain in weight among the girls who had been taking this pint of milk each day. They looked better and they volunteered the information that they were doing better work.

The result of this experiment led to the belief that, if a readily available and

*Received for publication March 10, 1922.

more potent nutritious substance were supplied, a greater gain in weight might be expected; consequently, it was decided to go through the factory, pick out the girls who were frankly undernourished, and give them between meals an 8-ounce glass of milk fortified by some form of carbohydrate. At the beginning of the study the undernourished were divided into three groups; to the first group Ovaltine was given, to the second group Horlick's Malted Milk, and to the last group Mellin's Food, in order to test the comparative adaptability of these three products. After several weeks it was realized that the girls who were receiving extra nourishment looked better physically and, without exception, had gained weight. The foremen of the plant, who had watched this experiment with a great deal of interest, were thoroughly convinced, long before we cared to make any definite statement, that these girls were doing better work.

In order to carry the study further, we decided to weigh every employee and take her standing height and age, and, by means of the table prepared for this purpose, to record the number of pounds overweight or underweight in each case. It was found that 42 per cent. of the women employed were underweight according to the tables by Friedenwald and Ruhräh (1). Realizing that these tables are only approximations, however, we decided to give extra nourishment to two different groups: first, to those who were at least 10 pounds under normal weight; second, to all those who returned to work after an illness or a surgical operation. It then occurred to us that it would be interesting to plot a curve of the weekly weight, and a similar curve of the efficiency record of the employees who were doing piecework. For this purpose the appended chart was used. (Fig. 1.)

Explanation of Efficiency

A word of explanation as to how these efficiency figures are obtained might not be out of place. A certain machine, for example, moves at a given rate of speed which is not too fast to permit the ordinary worker to keep it filled at all times. This means that a given number of articles should pass through the operator's hands in one hour. If the machine stops or if any other factors interfere with the proper performance of the employee, through no fault of the employee herself, this amount of time lost is subtracted and is not charged against efficiency. An operator, then, who keeps up with the speed of the machine has an efficiency of 100 per cent. If any of the products are damaged or broken by carelessness or inexactness, however, the efficiency figures are affected. In departments where there is no machine to establish the rate of production, there is a theoretical efficiency figure based on the number of products that several of the best workers can complete in an hour.

It will readily be seen that there are many factors which will influence these efficiency figures, and that comparisons of this phase of any two departments will not be accurate. On the whole, however, this basis of calculating efficiency, provided care is taken to check up each individual record, is about as accurate as one can hope for.

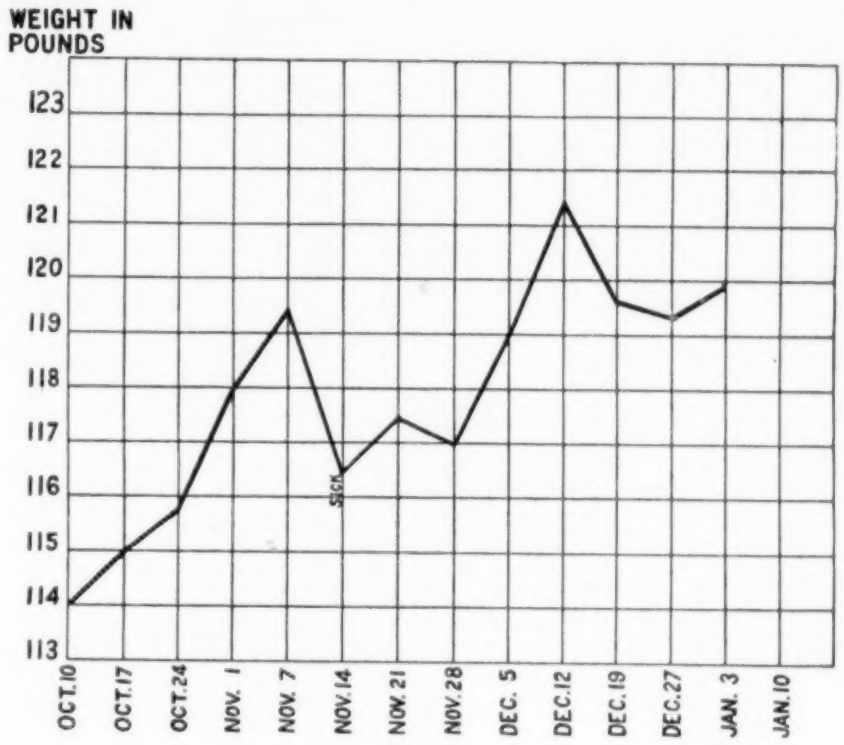
It is fully realized that extraneous factors influence the efficiency of employees, and will affect their ability to concentrate and to sustain continued

FIGURE 1

SUPPLEMENTARY NUTRITION RECORD

Name: Mary Smith. Department: Stem.
Indication for administration: Underweight and low efficiency.
Nourishment prescribed: Mellin's and Horlick's. A.M. 10 oz. P. M., 10 oz.
Initial weight: 114 lbs. Date nourishment started: Oct. 10, 1921.
Correct weight for age and height: 125 lbs. Peledisi % 97.
Final Peledisi % 99.

Weekly Record		*Daily Nourishment Check*					
PERIOD	NO.	M.	T.	W.	T.	F.	S.
Oct. 10-14	1	||	||	||	||	||	—
" 17-21	2	||	||	||	||	||	—
" 24-28	3	||	||	||	||	||	—
Nov. 1-4	4	—	||	||	||	||	—
" 7-11	5	||	||	||	—	—	—
" 14-18	6	||	||	||	||	||	—
" 21-26	7	||	||	||	||	||	||
" 28-Dec. 3	8	||	||	||	—	||	|
Dec. 5-10	9	||	||	||	||	||	|
" 12-17	10	||	||	||	||	||	|
" 19-23	11	||	||	||	||	||	|
" 27-31	12	—	||	||	||	||	|
Jan. 3-7	13	—	||	||	||	|	|



Total amount of nourishment taken: c.c., 34,800; ounces, 1,160.

EFFICIENCY RECORD

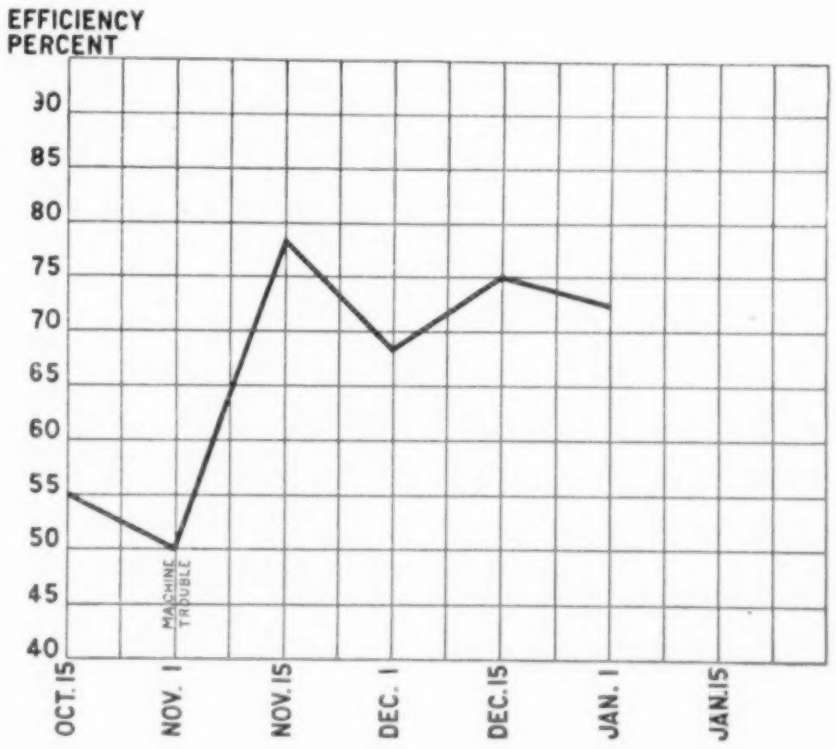
Nature of occupation: Semi-automatic.

Previous efficiency 55%

Average efficiency of dept..... 70+%

Total weight increase..... 6 lbs.

Total efficiency increase..... 17%



application to any oft-repeated operation. Among these factors the most important seem to be sickness in the family, late hours, and pre-nuptial activities; kind and quantity of food taken at home must also be mentioned. Moreover, native ability must be considered when the efficiency of any two operators is compared. It is an undisputed fact, all things being equal, that one person will excel in a given task because of inherent aptitude, but this should not, we believe, account for differences of more than from 10 to 15 per cent.

There is yet another factor which influences production, and that is motive. For instance, a girl who is supporting her mother and small brother will try harder to have a good income than the girl who is living at home and working just for something to do.

There is a psychological stimulation which enters into any new procedure among workers, and this fact must, we believe, be taken into consideration in these observations. Each individual is told the reason why she is being given extra nourishment, and at the same time it is explained that one of the results following her gain in physical strength will be an ability to produce more. Consequently, when the weight curve begins to ascend, the employee is convinced of the success of the effort to make her better physically, and takes it for granted that she can do better work. The old adage that "nothing succeeds like success" might be appropriately quoted here, especially since there is visual evidence of success.

In compiling our results, the actual efficiency figures arrived at by the various departments are taken as they are turned in. Notations are made on each chart, explaining any factors, such as those cited in the foregoing, which influence the efficiency of the worker in question. At the present time we are not prepared to make any definite statement as to the average gain in efficiency. Further investigation is being carried on, however, and a report will be made when more accurate data are available. Meantime, it will suffice to say that in practically every case there is a decided increase in the amount of work turned out by the underweight employees to whom extra nourishment is given.

Method of Procedure

When it has been decided to give extra nourishment to an employee, every precaution is taken to eliminate disease as the cause of her malnutrition. Each employee has previously had a thorough physical examination, so that this point is not so important in our plant as in plants where physical examinations are not the rule. Nevertheless, a very thorough re-examination is made, in which such points as general appearance, color of the mucous membranes, tone of the musculature and skin are noted, and a record made of the standing and sitting height in centimeters, and of the weight in kilograms and pounds. The urine is examined, especially for sugar. The idea of the experiment is explained to each employee, and instructions are given to report to the dispensary each day at 9:30 A.M. and at 3 P.M. It is suggested that the nourishment be served from the dispensary rather than from the cafeteria, so that the procedure will seem more like a health measure than a lunch proposition, and also so that the medical staff may have an opportunity to observe the nutrition class more closely, and may be better able to suggest variations

in the kind and quantity of nourishment.

The basis of the extra nourishment is whole milk with a 3½ per cent. fat content. Unless there is some contra-indication, 10 ounces are prescribed for each feeding. To add to the food value, some form of carbohydrate is used with the milk, such as cane sugar, lactose, Mellin's Food or Horlick's Malted Milk. Ovaltine was used at first but was found to be too expensive to use in large quantities, although we believe that it has distinct merits. For patients who are constipated Mellin's Food seems to be very satisfactory, as it is slightly laxative. Three level tablespoonfuls of Malted Milk or Mellin's Food, or approximately 1 ounce, are added to each 10 ounces of milk. According to the manufacturer's directions, Mellin's Food should be mixed at least two hours before serving in order that the curd will be softened. Both Horlick's Malted Milk and Mellin's Food are more easily taken over a long period of time if they are slightly flavored with chocolate. Various other combinations, including a mixture of the two foods, have been prepared by our plant nurse, and have had a very satisfactory taste. Cane sugar and lactose do not, for the most part, seem to be as suitable as the dextromaltoses.

The food value supplied by the above mixture is approximately 300 calories per glass or, calculated by Pirquet's table, 480 *nems* (the nem being the food value of 1 c.c. of milk). This means that those fortunate enough to be placed on the nutrition squad are given about one-fourth of their daily food requirement. The cost of such mixtures, based on milk at 30 cents per gallon, is 5 1/3 cents per glass.

Ninety per cent. of the nutrition class take one of the mixtures, which we have mentioned, without discomfort. Occasionally there is a complaint of digestive disturbance, but this is usually rectified by reducing the quantity, changing the food, or cutting down the amount of carbohydrate or fat. In some instances the intermediate feeding interferes with the regular meal; in these cases the food can be taken with the meal and at night before retiring if the individual is willing to buy it for herself. (This has been done with good results in several cases.)

Our first charts were prepared to cover a twelve-week period, and this seems to have been a fairly good estimate, as most of the workers have made satisfactory gains in that time, and some have reached normal weight in even less time.

Reference has been made to the fact that in the beginning of our study we recorded each employee's weight in kilograms and her sitting height in centimeters. These figures are obtained in order that the system of nutrition devised by Pirquet may be used. The percentage nutrition, or *peledisi,* as expressed in his tables, seems to us to be the most satisfactory way of approaching the question of what constitutes normal, when speaking of nutritional standards. Unfortunately, the tables published in this country are complete only to include a sitting height of 90 centimeters. Comparisons between this and other systems are now being made. Complete *peledisi* tables have just reached us from Vienna, including sitting heights up to 100 cm.[1]

[1] Our request for complete tables was answered very generously by Dr. Schick of the Kinderklinik in Vienna, and we have a few extra copies which we will gladly send to anyone desiring them.

Because of the variation in the amount of breast tissue among women, we have not used the sitting height bust measure as an index of nutrition in our cases.

Suggestions

To those who study the weight curves of employees taking extra nourishment, there will come some disappointments at the beginning. In a few instances the weight curve falls, but it rises again in 98 per cent. of the cases, and keeps rising as long as sufficient intermediate feeding is given.

To insure success, the administration of the nourishment should be under the direct supervision of a nurse who is interested and who does not feel that it is a burdensome duty.

Provide the nourishment free of charge for at least twelve weeks; then, if the employee so desires and if it is thought best to do so, permit her to pay for it.

Explain the proposition to the foremen and ask their co-operation in selecting persons who would possibly be benefited. Suggest that they send to you employees doing noticeably poor work. This will afford an opportunity to detect incipient diseases. It has been found to be of distinct value in instituting preventive measures, which are timely not only from the standpoint of the individual but also from the standpoint of her associates.

Much has been written about relaxation and short exercise periods during work hours. The plan of having employees report to the dispensary rather than having the nourishment served to them at their machines is in keeping with this idea.

The food recommended is of high carbohydrate value. As a matter of safety, therefore, the urine should be examined to exclude the possibility of glycosuria before the procedure is begun.

Results

Since August 15, 1921, records have been kept of seventy-five employees to whom extra nourishment has been given, gratis. They may be grouped as follows: 33 active cases; 11 short period cases; 31 completed cases. The active cases include new employees who are underweight, old employees who are losing weight, and those who are convalescing from illness or operation. It will readily be seen that this is a constantly changing list.

The most satisfactory results have been noted in the group last mentioned, the convalescents. There is a steady gain in weight among the members of this group, and we feel that the return to normal health is much more rapid than when no extra nourishment is given. Moreover, in this group will be found the most appreciative patients. Their loyalty to the institution is greatly enhanced as a result of the interest in their welfare shown by the medical department. The short period group consists of those who, for any reason, stopped taking the nourishment before two weeks had passed. In this group are included those who were laid off work, two employees who had digestive disturbance, and several who were not interested enough in their own welfare to climb two or three flights of stairs to get their nourishment. The completed case group includes all those who received the nourishment for four weeks or more.

Up to the present time one-half of our diet squad have been time workers

and of course no efficiency figure is available on this group. The final result in this instance is arrived at by noting the increase in weight, the comparison of the physical condition with the record kept on the back of the chart (that is, general appearance, color, muscular tone, condition of skin), and, in addition, the statement of the patient herself. In 90 per cent. of the cases the patients have stated that their general health is improved, that they are feeling better, and that they have lost less time on account of illness than ever before.

The greatest gain in weight recorded was 12 pounds in twelve weeks. The average weight increase was 5 pounds for those who had been in the squad for more than four weeks. Two girls lost slightly in weight but gained in efficiency. The weight curve is a very sensitive one, being influenced by many factors. Slight colds, minor injuries, sickness of some member of the family, and insufficient sleep, all have a decided tendency to cause loss of weight.

In the group for which efficiency figures were available, twenty-two gained in production, seven showed no change, and five lost. In two instances the gain in efficiency was such that it made the worker the best in her department.

An interesting finding has come to light in the study of the influence of this régime on hourly production. An endeavor was made to find that peak of efficiency followed by the "fag" period, about which one reads so much. It was hoped that proof could be offered to substantiate the statements that energy provided in the readily assimilable milk and dextrose mixture would tide the worker over this period, but no such falling curve can be plotted of the production in this establishment. It was surprising to find that the number of products turned out by a given worker during the second hour of the work period in nearly every instance represented the number which obtained in all successive hours of the day. This is explained by Dr. Lee[2] as follows: "Where work is monotonous and where it is frequently broken by natural pauses, a curve may be obtained which for both working spells is nearly a straight and horizontal line, showing a slight practice effect but no fatigue." A similar curve can be constructed of the hourly production in our plant.

The energy provided by the extra nourishment seems to increase efficiency by benefiting the general health of the recipient and not by any temporary effect such as would tide the individual doing heavy, prolonged muscular work over a period of exhaustion.

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GERMAN LITERATURE ON THE WHITE LEAD QUESTION, 1921*

LUDWIG TELEKY, M.D.

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THE decision of the Washington Conference (November, 1919) that the question of the prohibition of the use of white lead in painting should be placed on the agenda of the next International Labour Conference, now (October, 1921) meeting in Geneva, provoked a heightened interest in the subject in all countries—in Germany as well as elsewhere. There follows a short summary of the German literature which has appeared on the subject.

Schoenfeld (1) sees in the blood changes, especially in the basophilic granulations, a reliable aid in recognizing the first stages of lead poisoning. He examined the blood of numerous workmen who had been reported to the Leipzig Sickness Insurance Office as lead poisoned, and was able by this means to determine that, in a large percentage of the workmen, the diagnosis of plumbism was incorrect. Of those incapacitated supposedly on account of lead poisoning, only 9 per cent. of the compositors, 38 per cent. of the painters, and 90 per cent. of the workers in ceramic color printing showed characteristic blood changes. Since the verification of the diagnosis of lead poisoning in the Sickness Insurance Office has been made dependent upon blood examination, the number of cases of lead poisoning has considerably decreased. That the number of demonstrable cases of lead poisoning has been increased through the elimination of cases incorrectly diagnosed, is undoubtedly true. I doubt, however, whether the figures are correct even as they now stand, inasmuch as Schoenfeld overlooks the fact that among those either not reported, or reported sick under some other diagnosis, there must be some persons suffering from lead poisoning. Contrary to the statements of Schoenfeld, Böttrich (2) emphasizes the importance of purely clinical symptoms—*i. e.*, lead line and lead pallor.

Schwarz has published two articles on blood examination in lead poisoning suspects (3) (4), in the first of which he discusses the technic of the thick drop method. This is easily carried out during the examination of large groups of persons as it does not require careful cleaning of the slide; furthermore, it simplifies the finding of basophil-granular red cells or their remains. After the remains of polychromatic or basophil-granular red cells have been found, then, in order to count the relative proportion of these cells, ordinary blood smears are prepared. With practice it is possible to estimate with some precision whether cells with basophil granulations are present in greater number than in normal blood. Schwarz was able, by this method, to stain and examine the preparations from fifty-one painters in three and one-half hours. Two observers looked over ten fields in each preparation and classified them as doubtful, positive, or negative. Then smears

*Translated by Dr. John W. S. Brady, Harvard Medical School. Received for publication Jan. 23, 1922.

were prepared by other observers and 200 fields on each slide were examined —a procedure which required about three and one-half working days. The results of both methods were in agreement. Without doubt when this method becomes established, the examination of large groups of persons will be considerably simplified; indeed, it may be that not until then will mass examinations become possible.

Süssman (5), working in Lehmann's Institute in Würzburg, made a series of extremely careful experiments on skin absorption in cats and guinea-pigs. The absorbed lead or mercury was demonstrated by the study of carefully collected urine and feces. An attempt at self-experimentation failed, owing to the fact that specimens of stool obtained before the beginning of the experiment contained lead. In spite of the extreme accuracy and conscientiousness with which the animal experimentation was conducted, the conclusions drawn by the author do not seem well founded. That there is no essential difference in absorptive power between the skin of man and the nearly sweat-glandless skin of cats has not been shown beyond reasonable doubt by Süssmann's self-experiment; nor can his estimate, that in therapeutic inunction only a third of the absorbed mercury finds its way through the skin, stand as proven. One must, however, agree with the author that his experiments seem to show the amount of lead absorbed through the skin to be so small (0.1-0.2 mg. of lead per square decimeter of skin as a daily average) that the possibility of industrial lead poisoning through skin absorption must be denied. I should like to add that exception must be made in the case of actors, dancers, etc., since it is to be expected from these experiments that where large surfaces of skin are covered with lead ointments, used as make-up, there may easily be enough skin absorption to produce poisoning.

Of the writings growing out of the controversy in regard to the prohibition of white lead may be mentioned first the reply of the Association of German White Lead Manufacturers of Cologne (6) to the memorandum of the International Labour Office, containing a supplement in which are given evidence and testimony. The "Reply," a polemic against the pamphlet of the International Labour Office, maintains that white lead is irreplaceable for painting purposes, and that the prohibition of its use for painting would undoubtedly be the first step toward *universal* prohibition of all lead colors. It stresses the indispensability of white lead, litharge, and minium for various industrial purposes; further, it attacks the correctness of published statistics in regard to the frequency of lead poisoning by referring to the investigations of Schoenfeld; and, finally, it calls attention to the economic damage that would result to Germany from the prohibition of the use of lead colors. In the supplement, various Associations of Master Painters express their opinions as to the impossibility of replacing white lead in outside work. A number of shipyards and iron construction companies emphasize the necessity of employing lead colors, as do a number of other industrial establishments, such as rubber factories, glass makers, linoleum factories, electric works, potteries—in short, a long list of industries in which no one thinks of forbidding the use of either white or red lead. Characteris-

tic of the preparation of the pamphlet is the inclusion of the protest of a large part of the employees in white lead works against the "prohibition of the manufacture of white lead."

The Düsseldorf Chamber of Commerce (7) also takes its stand against the proposed prohibition of white lead in a memorandum on "The Use of White Lead in the Painting and Decorating Trades." This memorandum gives a short summary of the present-day status of legislation. It is the opinion of the Chamber of Commerce that in interior work, at least as a covering paint, white lead is unquestionably replaceable, but that in outside work it is indispensable. Even with the high price of linseed oil and although zinc white requires more linseed oil than does white lead, the cost of a single coat per square meter is considerably higher with white lead than with zinc; nevertheless, on account of its alleged poorer covering power, more coats of zinc white are required, and the cost of the completed job with zinc white is consequently somewhat higher than with lead. Furthermore, the zinc coating has to be renewed in a short time. The article quotes the statistics of lead poisoning in Berlin and Hamburg in the pre-war period, and challenges their correctness on the basis of Schoenfeld's investigations. It mentions the economic consequences of the prohibition of lead colors, and maintains that lead smelters are dependent for the disposal of their product on the lead color manufacturers who utilize about one-third of the output; and that if lead color manufacturers should be driven out of business, other industries employing lead compounds would be similarly affected (?).

Another pamphlet on the same subject (8) published by the Union of German Painters, Varnishers, etc., shows how the Union, the Social Democratic Guild of Painters, has for the last twenty years been leading the fight against lead colors, and presents a series of data in regard to sickness in the painters' trade (rheumatism, eczema, tuberculosis, nephritis), taken from the writings of Koelsch (9) (10). Then follow details of lead poisoning and its symptoms. The prohibition of dry sand papering contained in the present regulation is declared to be impracticable, since wet rubbing down, the process to be substituted, is impossible for technical reasons which are outlined, as well as on account of the cost. Dry sand papering is thus technically necessary and economically justifiable. During this process, however, inhalation of dust is unavoidable, since respirators and wet sponges are too great a hindrance to breathing. Replacement of lead for indoor work is unquestionably possible. While it is true that outdoor work with lithopone often becomes more quickly damaged, this is due to inexpert workmanship. With intelligent use, zinc white and lithopone can readily replace white lead even in exterior work.

The same guild also published a thirty-eight-page lecture which was delivered at its General Assembly in July, 1921, by Dr. Koelsch, the Bavarian State Industrial Physician, entitled "Harmful Effects of Lead in the Painting and Varnishing Trades from the Point of View of Physician and of Legislator" (11). Koelsch discusses the kinds of lead colors, the modes of entrance of lead into the body—namely, the inhalation of lead dust and the direct conveying of lead to the mouth by the hands—and the rôle of personal

susceptibility, and then presents copious statistical material in regard to the frequency of poisoning in different localities. He also gives a résumé of the regulations which have been issued for the protection of painters in Germany, discusses their value, and concludes that the present statute with its prohibition of dry sand papering and its provision for cleanliness has not led to any far-reaching improvement of health conditions. He points out the success which followed the prohibition of the use of lead colors in indoor work in Austria, and mentions investigations in regard to the merits of lead-free and lead-containing pigments which have been carried out by various official departments in Holland, Denmark and France. Finally, he demands the prohibition of the use of white lead for indoor work with certain extensions (carriages, automobiles, garden furniture, machines), and also recommends obligatory declaration of contents. It is his opinion that lead-containing paints should be sold and used only with the label *Lead-Containing—Poisonous*. Medical supervision of decorators and painters using lead paints should occur at intervals of two or three months. Technical justification for the prohibition of the use of lead colors for exterior work does not seem to Koelsch to be sufficiently established as yet.

Teleky (12), in his article on "The Use of Lead Colors in Painting, the Danger and Its Prevention," attempts an objective presentation of the question. He points out, first of all, to those who see in the international prohibition of white lead a hostile action directed against Germany, that the Geneva International Labour Office of the League of Nations is only continuing the work begun under German leadership by the International Union for the Legal Protection of Workers in Basel. He shows that, although Schoenfeld may be right in saying that in many trades, especially printing, too many cases have been wrongly diagnosed lead poisoning, on the other hand, many cases of lead poisoning have been unrecognized; and that at all events the number of cases of poisoning among painters is distinctly high. The decline of this number during and after the War must be laid to a lack of lead colors and to the depression in building activity. Since lead poisoning results chiefly from the inhalation of lead dust, workers in interior painting for the most part become sick as a direct result of the necessary dry rubbing down. On account of the fact that house painters are constantly changing their work places, it is impossible to carry out and supervise effectively any protective measures that may be prescribed. The writer knows this from his experience in Vienna; but in addition statistics show that in Vienna, where the use of white lead in interior decoration is prohibited, the incidence of lead poisoning in painters has fallen to one-third; whereas in Berlin, where other protective measures only (without prohibition) are in force, after falling to one-half, the incidence rose again to its former height. With regard to the technical possibilities Teleky finds support in the evidence gathered by the Dutch Royal Commission. He points out that, since Germany produces much less lead than its industrial needs demand, considerable quantities of lead must be imported; and that economic harm to the country, as maintained in the statement of the white lead manufacturers,

would not result, since the zinc color industry in Germany is very highly developed and shows a constantly increasing export. Teleky considers the prohibition of lead colors for indoor work (extended to window frames, garden furniture, carriage and automobile enamel) to be absolutely essential, and technically possible to carry out; he considers equally necessary the prohibition in all kinds of painting of the use of red lead, which is unfortunately often forgotten in the discussion; and, in addition, compulsory declaration of contents. Even in exterior painting, prohibition of white lead is necessary in spite of the technical difficulties of finding suitable substitutes.

Teleky's articles gave Schoenfeld opportunity to write "An Answer and Justification" (13) in which he maintains his point of view. In a further work, "The Impending Prohibition of White Lead and Methods of Blood Examination as a Prophylactic Measure" (14), he explains his opinions in detail. New is the fact that in addition to the granular red cells he attributes great importance to the polychromatophilia. He attaches no value to the number of basophil erythrocytes and sees in their presence (no matter in what number) not the signs of lead *poisoning,* but rather merely the signs of lead *effect.* He demands, therefore, not that the workmen with positive blood findings be kept from lead work, but merely that they be placed under especially careful supervision. From this point of view, it seems, the demonstration of granular cells has lost a great deal of its practical value.

In a short article on "The Use of Lead Colors in the Painting Trade" (15), Teleky replies to the new statements of Schoenfeld. He points out that up to the present time prescribed periodic medical examination has not obtained the desired result in many factories. The white lead industry itself, which now finds the methods of Schoenfeld so promising, has already had enough opportunity to demonstrate that by means of regular medical supervision and examination all dangers can be avoided. But the proof of this is still lacking.

In the meantime the closing of the Geneva Conference has put at least a temporary end to this discussion. In spite of the recommendations of the special commission, the main assembly very justly voted in favor of the prohibition of the use of white lead in interior painting—a prohibition which, unfortunately, is weakened by a number of exceptions and by an all too long delay in its introduction. In the meetings of the committee there was one unpleasant circumstance, in which the Geneva Session of the League of Nations differed from former international conferences called by the International Association for Labor Legislation, and this difference was by no means to the credit of the Geneva Conference. In the conference of the International Association the governments of the various countries were represented as well as workmen and employers, but the body of the Assembly was composed of sociologists, of experts in the field of social legislation, and the sub-committees of experts in their corresponding fields. In Geneva, however, it was primarily the representatives of governments, employers and employees who had the floor. Experts were present only in so far as they were brought by one of these groups. Hence the following situation resulted: In so far as scientific experts (doctors,

national economists, sociologists) were necessary, the employers selected those experts in their countries who represented most nearly their point of view and brought them to Geneva at their own expense (for countries with depreciated currency the cost of this trip was a large item). The labor representatives did the same, but expense was a far more serious item for them than for the employers, and consequently they were obliged in great part to forego the service of experts. The governments, which had for the most part already stated their stand in the matter, likewise secured for themselves experts who shared their opinions. On this account the conference, instead of consisting of those experts from various countries who had occupied themselves most intensely with the question under discussion (as was the case in the previous labor conferences), was rather made up of those who seemed to the various parties best suited to represent their partisan opinion. And the workers' viewpoint, on account of the great expense, was far too poorly represented. The white lead committee consisted of nine "experts" for the governments, eleven for the employers, and four for the workmen, with no doctor among them. In this respect it would seem that the whole organization of these conferences is susceptible to improvement.

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BACK AND FOOT STRAIN*

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BACK strain and foot strain are loose but convenient terms under which may be grouped a large variety of rather ill-defined and little understood conditions. Collectively, they are responsible for a high percentage of disability among employees, and the duration of the affection and ultimate result are always matters shrouded in mystery. The questions of treatment and prevention which constitute the real problem of the industrial surgeon are wholly dependent upon the recognition of the underlying causes, and for this a thorough understanding of the anatomy and physiology of the region is necessary.

BACK STRAIN

Anatomy of the Spine.—The vertebrae are composed of two parts, the body, or weight-bearing portion, and the spinal arch with its accessory processes, the function of which is to protect the spinal cord and provide attachment for muscles and ligaments.

The bodies articulate with each other by means of the intervertebral disks which have resistant semi-fluid centers but elastic, compressible peripheral layers, so that rocking motion or rotation in any direction is permitted. The spinal arches are joined by articular processes projecting upward and downward in pairs from each vertebra. The joints so formed are true joints, lined with cartilage and surrounded by capsule. The shape of these articular processes varies, however, in different segments of the spine, and as their function is to limit the motion of the vertebrae, it will be seen that the type of motion permitted at different levels is directly related to the shape of the process.

In the dorsal region the articular processes are vertical and flat and face in the anteroposterior plane, thus permitting flexion and extension, lateral bending and rotation. At the same time each of the vertebrae in this region supports a pair of ribs and the relation of the latter to the thorax results in considerable secondary limitation of motion, chiefly affecting flexion and lateral bending. In the lumbar region the articular processes are normally crescentic in cross section, and vertical. This shape limits rotation but permits free flexion and extension and lateral bending.

The vertebrae are bound together by strong anterior and posterior common ligaments extending from the sacrum to the occiput, covering the bodies and the disks. The ligamenta subflava are strong elastic ligaments which run along the posterior surface of the spinal canal and are attached to the laminae. The interspinous and intertransversalis ligaments join the spinous and transverse processes, respectively. Motions in the anteroposterior and transverse planes are checked by the tension of the ligaments on the sides of the bodies opposite to the direction of the movement, and also by the resistance to com-

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pression of that edge of the intervertebral disk toward which the motion occurs.

While the extensive range of motion of the whole spine is the resultant of many slight movements between the individual vertebrae, the greatest degree of movement occurs at the points of junction between the fixed and unfixed portions as represented by the dorsolumbar and lumbosacral articulations.

The lumbosacral articulation presents certain peculiarities not found in the other spinal joints. The body of the fifth lumbar is higher in front than behind, and the disk between it and the sacrum is of greater thickness than the other intervertebral disks, especially in the anterior portion. In addition to being supported by the common spinal ligaments, this joint is reinforced by strong fibrous bands extending from the transverse processes of the fifth lumbar laterally to the iliac crest and downward to the sacrum, the iliolumbar and lumbosacral ligaments, respectively.

The sacrum is formed by the fusion of five vertebrae, of which the upper three serve to support the pelvis laterally, by entering into the formation of the sacro-iliac articulations. These are true joints, lined with articular cartilage and containing synovial cavities. The sacrum is broader in front than behind, so that on cross section the joint line is oblique, running backward and inward, as shown in Figure 1. The surfaces are gently irregular, tending slightly to interlock. They are held together by the anterior, superior, and posterior ligaments. The posterior ligament is by far the strongest, as its function is to sling the sacrum and resist the tendency of the body weight in the upright position to force the sacrum forward into the pelvis. It comprises many layers of strong fibers filling the gutter-like space between the projecting posterior edge of the ilium and the surface of the sacrum. The normal motion at the sacro-iliac joints is slight and consists of rotation of the sacrum on a transverse axis passing through the second segment. Normally the antero-posterior diameter of the brim of the pelvis may be increased or lessened about 1 cm. by the extremes of this movement.

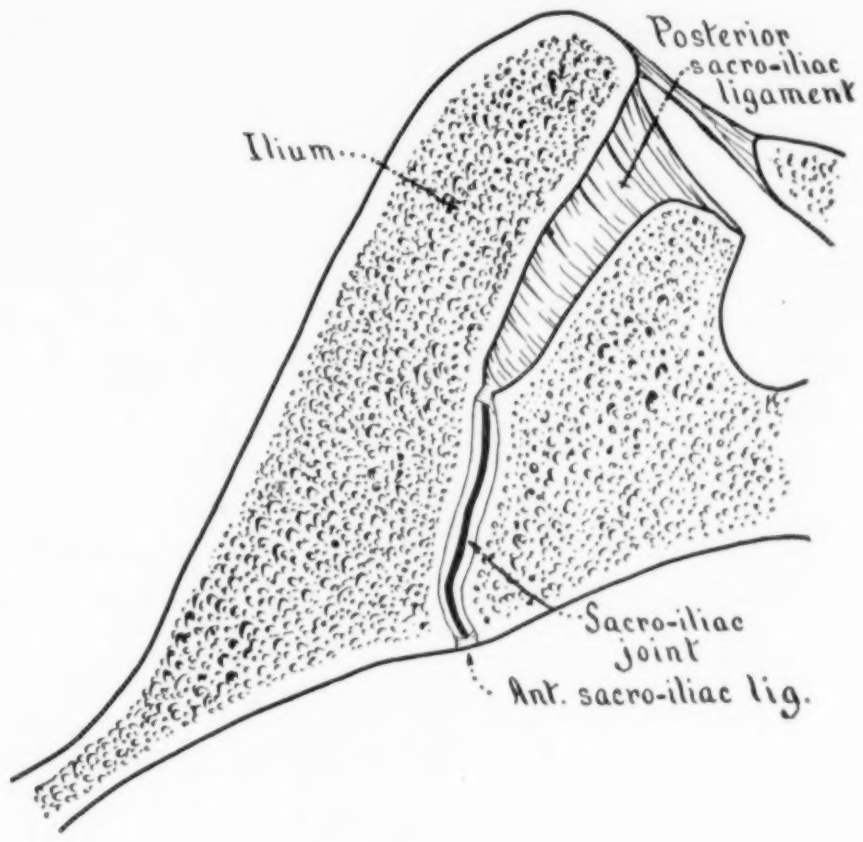

FIG. 1.—Cross section through the sacro-iliac joint. Note its sloping direction backward and inward.

The spine is supported and held erect by the balanced action of the various trunk muscles. The chief flexors are the recti abdominis and the psoas. The extensor muscles comprise the large muscular mass occupying the fossae formed by the transverse processes anteriorly and the spinous processes mesially, and are composed of the erector spinae, transversospinal and intervertebral groups of muscles. Lateral support is given by the quadratus lumborum and the external and internal oblique muscles.

The manner in which the spinal

nerves make their exit from the spinal canal through the intervertebral foramina and their close relation to the vertebrae and the spinal joints expose them to pressure and injury in conditions affecting the spine. The intercostal nerves may be involved in lesions of the dorsal spine with resulting intercostal neuralgia. By localizing the affected nerve the level of the spinal lesion may be determined.

In the lumbar and sacral regions the nerves join to form the lumbar and sacral plexuses. The lumbar plexus lies in the substance of the psoas muscle and is formed by the first, second, and third lumbar roots with branches from the twelfth dorsal and fourth lumbar roots. It gives origin to several nerves, among them the anterior crural and obturator nerves. Pain referred along the anterior or inner sides of the thigh or wasting of the quadriceps muscles, therefore, indicates a lesion in the upper lumbar region. The sacral plexus is formed by the junction of the first, second, and third sacral roots with the lumbosacral cord which contains all the fibers of the fifth lumbar and a branch from the fourth lumbar root. From it is given off the sciatic nerve. Parts of the plexus lie in close relation to the lumbosacral and sacro-iliac joints, and sciatic pain or muscular or cutaneous disturbances in the sciatic distribution in association with affections of the spine localizes the lesion at the pelvic joints.

The spine normally presents four curves which, in relation to the ventral surface, consist of a cervical convexity, a dorsal concavity, a lumbar convexity, and a sacrococcygeal concavity (Fig. 2). The dorsal and pelvic curves may be considered as primary curves, as these segments form parts of the pelvis and thorax and are comparatively rigid

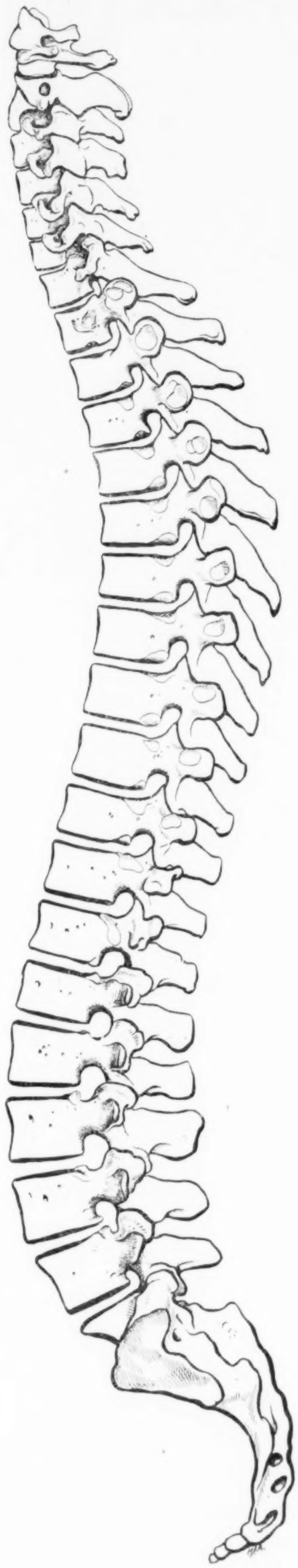

FIG. 2.—Lateral view of spine, showing articulations and normal curves.

portions although, as has been seen in studying the spinal movements, these curves are capable of considerable modification by flexion, extension, and lateral bending. The lumbar and cervical regions are the flexible connecting links and the chief balancing agents because they possess the greatest degree of movement. The cervical curve appears when the child begins to hold the head upright; the lumbar curve develops only when the vertical position is first assumed. They are, therefore, secondary curves intended to compensate for the normal inclination of the pelvis and the posterior convexity of the dorsal region.

Etiology of Back Strain.—The key to the entire problem of back strain lies in the proper understanding of the normal physiology of the spine. A perpendicular dropped from the occipitospinal articulation normally crosses the spine in the upper cervical, cervicodorsal, dorsolumbar, and lumbosacral regions. The cervical and lumbar curves project in front of the line, while the dorsal and sacral curves project behind the line. The balancing relation is so accurate that no one curve can be increased without corresponding increase of the others and, conversely, no one curve can be decreased without accompanying flattening of the entire spine.

With every movement of the body the center of gravity shifts, and compensatory change of the spinal curves in one or the other direction must occur in order to maintain balance. In the normal erect posture all of these curves are slight, and none of the spinal joints is used at its limit of motion. Balance may, therefore, be easily maintained. Moreover, the load is evenly distributed to all of the supporting muscles so that there is no excessive fatigue. The muscles can retain their normal tonicity, and the ligaments are protected from strain.

With incorrect habits of posture, however, the conditions are quite reversed. When the spine sags, its curves become exaggerated and the spinal joints are used at their extreme limit of motion. There is extreme hyperextension of the lumbar spine, increased flexion of the dorsal region, and also increased inclination of the pelvis. The ligaments which normally check extreme ranges of motion are constantly under tension. The normal balancing mechanism is lost because compensatory movements of the vertebrae can take place in but one direction. Movement in the other direction can occur only at the expense of the structures normally checking motion, with resulting strain and injury. Moreover, the muscles no longer carry their fair share of the burden of the body weight. Certain muscle groups atrophy as a result of disuse, and the load is borne by the ligamentous and bony supports. Other groups are overworked, become fatigued, and lose their normal tone. A vicious circle is thus formed because, with gradual weakening of the muscles, sagging occurs more and more, and this of itself results in still further weakening of the muscles.

The points in the spine which are most exposed to strain are the lumbosacral, sacro-iliac, and dorsolumbar articulations, because they represent junction points between fixed and flexible portions of the spine. In the incorrect position the sacrum is more horizontally placed than it normally is, so that the sacro-iliac joints derive less support from the shape of the bones. The sacrum is left hanging by its posterior ligaments, with the result that they may become relaxed and strained. The position of extreme hyperextension

of the lumbosacral joint causes the articular processes of the fifth lumbar to slide down until they rest against the sacrum, and painful bursae may develop beneath them. The body weight is transmitted to the sacrum by way of the spinal arch instead of by way of the vertebral body. The intervertebral foramina are narrowed, and nerve root compression may occur. The iliolumbar, lumbosacral, and all other ligaments supporting the joint are strained

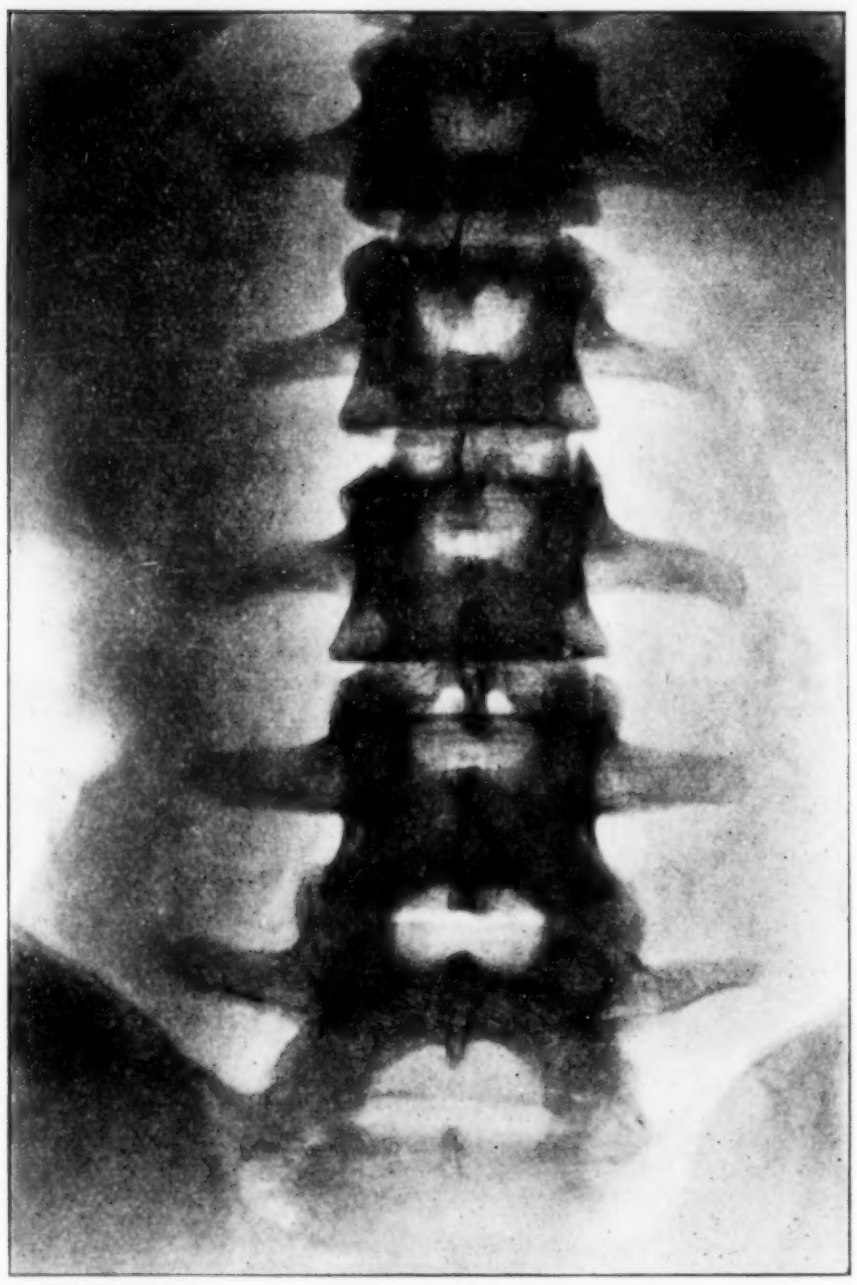

FIG. 3.—Lumbar spine. Slender type. The bodies of the vertebrae are square, the sacrum extends well upward, and the transverse processes of the fifth lumbar are well removed from the ilium.

and injured. Conditions are similar at the dorsolumbar junction, with resulting ligamentous strain, and in addition the last rib may be approximated to the transverse process of the first lumbar vertebra, thus making possible compression of the intercostal nerve.

Anatomic Variations of the Spine.—Variations from the normal or textbook anatomy are very common in the spine and, by lessening the stability of certain joints, may become factors in the production of strain. This variation may be one of number, shape, or development. Numerical variation, such as the presence of extra lumbar vertebrae, occurs frequently and gives rise to many interesting speculations, but is not an apparent factor in the production of strain.

Variation in shape is a frequent occurrence in the dorsolumbar and lumbosacral regions. In the former, the differences have chiefly to do with the development of the last ribs. They may be so small as to be barely visible, or again they may be quite long. There is also corresponding variation in the transverse processes of the first lumbar vertebra, and the relative development of these two processes may be important in determining the possibility of nerve compression when the body sags. In the case of the fifth lumbar, the transverse processes may show great variation. They may be long and slender, or heavy and fin shaped. They may be in contact with the top of the sacrum or the wings of the ilium, and may form true joints with either or both of them. In this case the stability of the lumbosacral articulation is increased, and the chief strain falls at the junction of the fourth and fifth lumbar vertebrae. Frequently, however, this over-development is one-sided only, and then it is easy to understand that an element of cross strain is brought to bear on the unsupported side and that this strain may affect not only the lumbosacral region but the sacro-iliac ligaments as well. (See Figs. 3, 4, 5 and 6.)

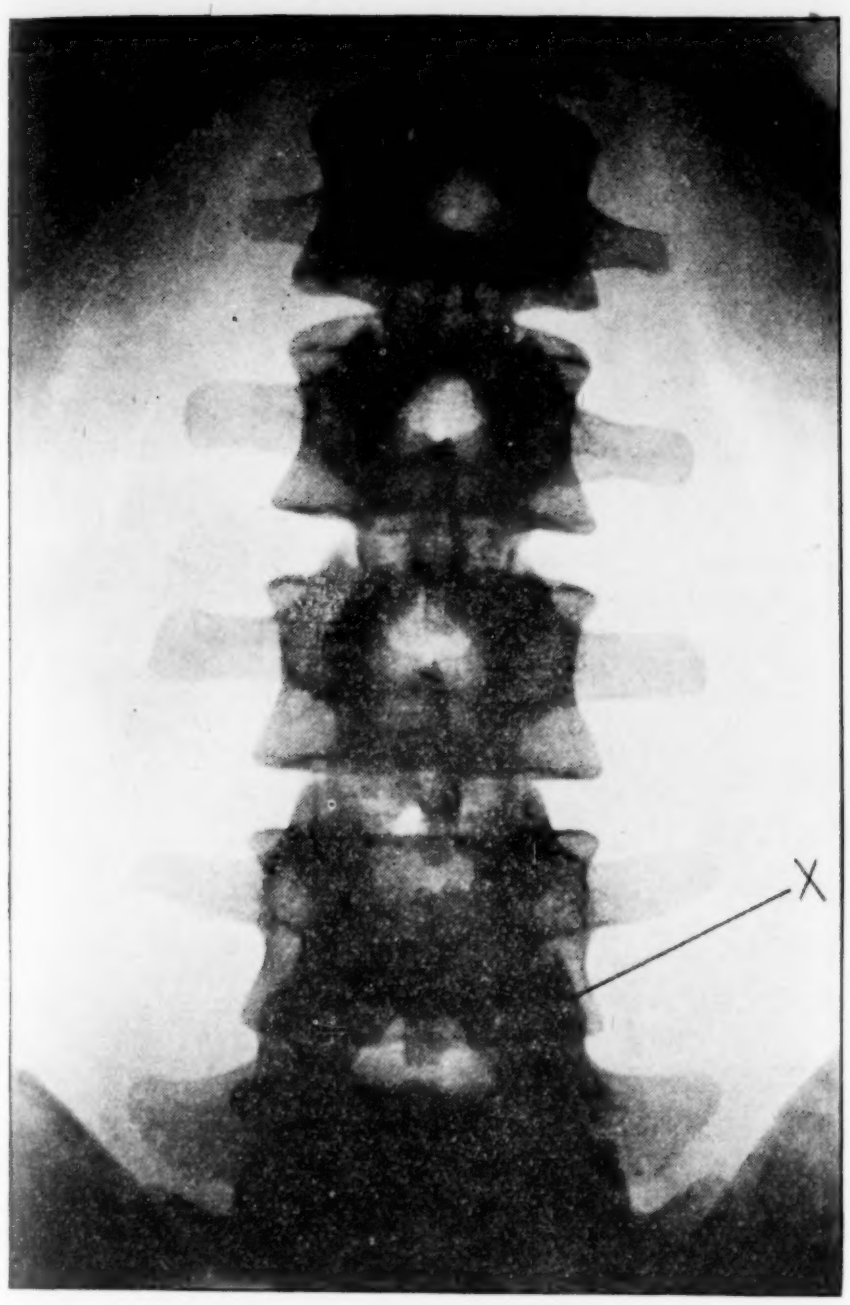

FIG. 4. — Lumbar spine. Heavy type. The width of the bodies is greater than their height, and the transverse processes, particularly those of the fifth lumbar, are broad, but not in contact with the ilium. The crescentic shape of the articular processes is well shown at X.

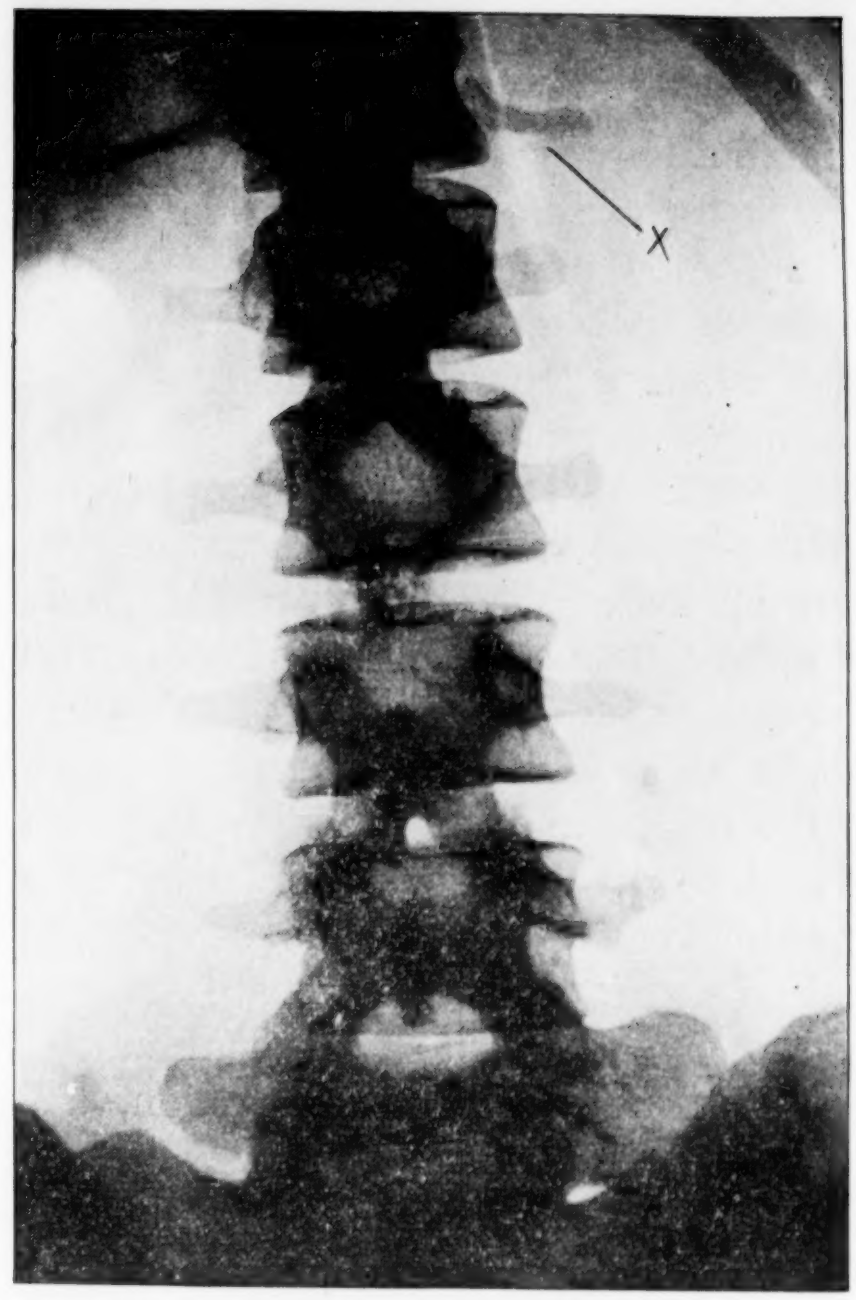

FIG. 5.—Lumbar spine. Mixed type. The upper four lumbar vertebrae are of the slender type with small transverse processes, while the fifth lumbar is distinctly broad with large transverse processes, one of which articulates with the side of the ilium and the top of the sacrum. What appears to be the first lumbar is really the last dorsal, there being an articulation for the costal element visible at X.

Variation in the shape of the articular facets at the lumbosacral region is also common. (See Fig. 7.) They may be quite flat and may look forward and backward instead of facing in two directions, or one may be flat and the other crescentic. The flat articulation gives stability in only one plane, allows greater motion, and is less well adapted to resist strain than is the normal crescentic process. An asymmetrical variation is essentially a poor mechanical arrangement and likely to give out under the influence of heavy work. Other variations frequently seen, which may also have an influence on back strain, are those due to developmental defects. These include incomplete closure of the spinal arches, or spina bifida occulta, usually involving the last lumbar and upper sacral vertebrae (Fig. 8), imperfect development of the body of the fifth lumbar, and twisting of the spinous processes from excessive crowding together during the formative period of life.

Diagnosis.—The differentiation of the various types of back strain is always difficult and can only be made after elimination of all other types of bone and joint pathology, such as tuberculosis, syphilis, arthritis, and neoplasm. A complete investigation of the pa-

tient's history and a thorough examination with the body uncovered are essential. The chief points to be noted on examination are the general attitude and body contour, the position of the spine when standing, presence or absence of listing, restricted and painful movements of the spine and hips, limitation of flexion of the hip with the knee extended, spasm of the erector spinae muscles, and points of tenderness on pressure over the pelvic joints or spine. The length of the legs should be compared by accurate measurements, as should also the circumference of the thighs and legs. Nerve function should be carefully determined by testing the reflexes, cutaneous sensibility, and voluntary muscle power. Last, but by no means least, the examination should include rectal examination, abdominal palpation, urinalysis, and blood-pressure readings, in order to eliminate extraspinal causes of back pain.

Roentgenographic examination is of distinct help not only in eliminating other bone and joint lesions but because of the information which may be gained as to the general structure of the spine and the presence or absence of anatomic variations. The effect of strain is often seen in the calcification of ligaments, especially the iliolumbar, or in the development of small hypertrophic spurs about the affected joints, or in bursal thickenings between the transverse processes of the fifth lumbar vertebra and the top of the sacrum. The plates should include stereoscopic views of the lumbosacral and sacro-iliac regions, and anteroposterior and lateral views of the lumbar and low dorsal spine.

The lesions to be differentiated under the general heading of back strain are: acute traumatic strain; general postural strain; dorsolumbar strain; lumbosacral strain; sacro-iliac strain; and combined pelvic joint strain. The classification is purely clinical, without reference to the exact anatomical lesion, but is distinctly helpful.

Acute Traumatic Strain.—This lesion represents a rupture of ligamentous or muscular fibers with all the phenomena of acute injury. The connection between trauma or violent effort and the sudden development of symptoms is always definite. There is acute pain, localized over the site of the lesion, which is increased by any movement of the spine. The body is held rigidly, spasm of the erector spinae muscles is great, and all movements of the spine are resisted. A point of great

FIG. 6.—Lumbar spine. The transverse process on the right side forms a true articulation with the sacrum and the ilium. The opposite side is not equally well supported and has tilted downward with the production of scoliosis.

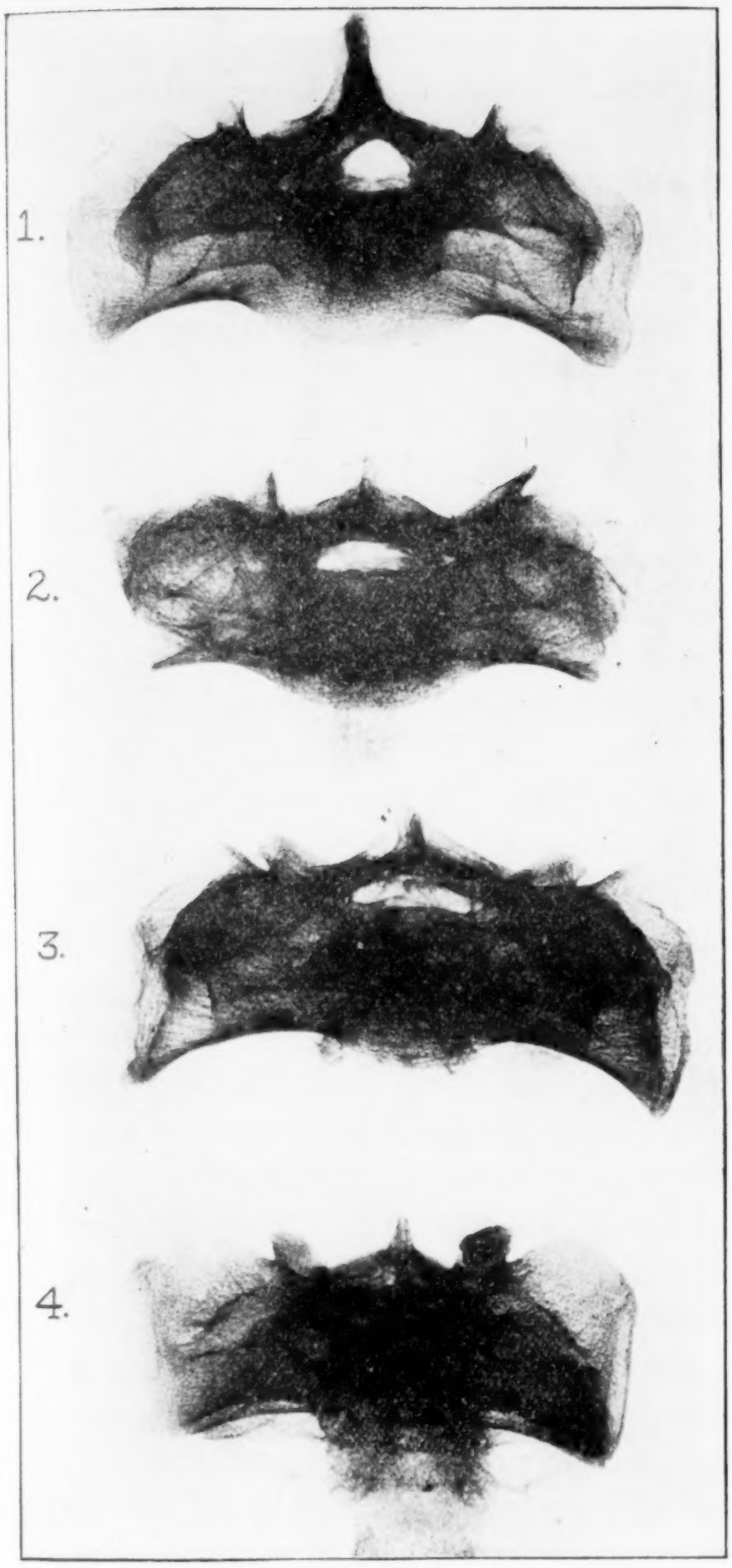

FIG. 7.—Variation in shape of articular processes of sacrum. Roentgenograms of specimens. (1) Normal processes; both crescentic. (2) Asymmetrical variation; left process crescentic, right flat. (3) Symmetrical variation; both processes flat. (4) Asymmetrical variation; both processes small but one on right particularly undeveloped.

tenderness to pressure may usually be demonstrated over the seat of injury. From its location and from the analysis of the spinal movements which are most painful a fair idea of the structures involved may be obtained.

General Postural Strain. — In this case the condition is one of general muscular fatigue and ligamentous strain and is not confined to any one joint. The complaint is of dull aching in the shoulders and low back, usually not present in the morning hours but coming on gradually as the patient becomes tired, and relieved by lying down. The patient is of the slender, asthenic type, and investigation of his social and occupational status usually shows that he lives under conditions of poor hygiene and is employed in some type of work which is particularly fatiguing or which favors the adoption of faulty postural attitudes. There is usually no nerve involvement or referred pain.

FIG. 8.—Congenital defect. Spina bifida occulta. Imperfect closure of spinal arch of first sacral segment.

Examination shows poor body mechanics and bad posture. There is no limitation of the movements of the spine or hips, and muscle spasm is absent. There may be points of tenderness to pressure between the spinous processes in the lumbar region.

Dorsolumbar Strain.—In this condition the pain is localized at the dorsolumbar junction. There may be only a dull steady pain or there may be exacerbations with acute knife-like pain on one side and evidence of nerve involvement with pain radiating forward to the chest along the course of the intercostal nerve. On examination there is found the usual sagging of the spine in the erect position. Spinal motions are usually moderately limited in the affected region but without much decrease in the total range of motion, owing to an increase in the movements of the vertebrae above and below the rigid segment. On palpation, spasm of the erector spinae muscles can be demonstrated, and there is marked tenderness, on pressure, high in the costovertebral angle.

Lumbosacral Strain.—The pain may be dull or acute and is sometimes localized in an indefinite way over the lower spine and hip, affecting chiefly one side, or in other cases is referred definitely to the lumbosacral angle. The pain is usually asymmetrical, and sciatica is a frequent symptom.

Among the various types of cases of lumbosacral strain, one in particular deserves special mention. This is the stout person with heavy, protruding abdomen. In order to accommodate the increased weight in front, the spine is tilted sharply backward at the lumbosacral junction, with production of marked lordosis. This results in strain of the iliolumbar and lumbosacral ligaments, with or without compression of the fourth and fifth lumbar roots, and sciatic pain.

Examination shows long standing bad posture. Spinal movements are usually fairly free but on lateral bending the participation of the lower lumbar vertebrae in the movement is often greater in one direction than in the other. Forward bending is often limited by spasm of the hamstring muscles, limiting the flexion of the pelvis on the hips. On palpation there is usually local tenderness, on deep pressure, in the lumbosacral angle or further out at the attachment of the iliolumbar ligaments to the iliac crests. The hip motions are free but flexion of the hip with the knee extended is usually limited on the affected side Careful nerve examination may show disturbances of cutaneous sensibility, muscular weakness, and atrophy.

Sacro-Iliac Strain.—The typical patient is usually a young or middle-aged woman, who has had one or several children. The pain is often first noticed during pregnancy when the normal physiological relaxation of the sacroiliac ligaments occurs. Following pregnancy the pain persists and consists of a dull ache through the low back, radiating to the hips and legs. Frequently the pain is noticed as much when in bed as when standing, and it is generally relieved by anything tightly encircling the pelvis. The patient is usually of the slender visceroptotic type, with relaxed abdominal wall and generally with poor body mechanics. The lateral movements of the spine are normal, but forward and backward bending are often painful or limited. Extreme abduction and external rotation of the hips are often painful, and there is marked limitation of the straight leg raising. There is marked tenderness, on pressure, over the posterior sacroiliac ligaments on one side, and this

may extend out into the gluteal region. There may also be tenderness on pressure at the symphysis pubis. Lateral compression of the crests of the ilium may be painful, and if the individual is thin, tenderness over the anterior surface of the sacro-iliac joint may be elicited by pressure through the abdomen.

Combined Pelvic Joint Strain (Sciatic Scoliosis). — Differentiation between strain of the lumbosacral and sacro-iliac regions is always difficult. In the more acute and more severe conditions the distinction is unnecessary because it is probable that they coexist, one resulting in the other. Sciatic scoliosis probably represents such a condition. It usually begins quite suddenly with severe pain in the low back, and is followed by the appearance of the characteristic sciatica. The pain is asymmetrical and so severe that the patient usually takes to his bed. After a variable period of time the back pain subsides but the sciatic pain persists and continues to be acute.

On examination the spine is seen to be listed to one side, the angulation beginning at the lumbosacral region, and one hip is more prominent than the other. All movements of the lower lumbar spine are limited and, if seen in the acute stage of the strain, are painful. Abduction and external rotation of the hip increase the pain. There is great limitation of the straight leg raising, so that on the affected side the heel can be lifted only a few inches from the bed. On the unaffected side there is similar but less marked limitation. Elevation of the leg on the unaffected side causes pain on the opposite and affected side.

Foot Strain

Anatomical Considerations.— Before considering the problem of foot strain, the arrangement of the skeleton of the foot should be recalled. The astragalus receives no direct muscular insertions of its own. Its motion is purely passive, being the resultant of the motion of the bones surrounding it. It is interposed between the tibia and fibula above, and the os calcis below, with each of which it articulates. In front it articulates with the scaphoid and, by way of this, with the cuneiforms and the three inner metatarsals. The os calcis has on its superior surface two articular facets which support the astragalus, and it articulates anteriorly with the cuboid and, by way of this, with the two outer metatarsals of the foot.

The motions of the foot are dorsiflexion and plantar flexion, supination and pronation, and adduction and abduction. Dorsiflexion and plantar flexion occur at the astragalotibial joint where, on account of the mortise-like action of the malleoli, no lateral motion is permitted. Supination and pronation, or inversion and eversion of the foot, take place almost altogether at the articulation between the os calcis and the astragalus, and are accomplished by an oblique rotation of the os calcis. Adduction and abduction are purely lateral motions of the forefoot, and occur chiefly in the anterior tarsal joints. Normally these movements scarcely exist and are demonstrable only as a sense of elasticity in the forefoot.

The foot is to be considered as an organ highly specialized for the purpose of bearing weight. Its general arrangement in arches conforms to the best mechanical principles of spring suspension. The longitudinal arch divides the weight between the heel and forefoot, while the anterior arch, by distributing the weight to the outer and

inner borders of the foot, gives practically a three point support. Normally most of the weight is transmitted to the heel and head of the first metatarsal, the outer border of the foot serving as the stabilizing arm of the tripod to prevent it from capsizing.

The arches do not, however, possess any inherent strength from the arrangement of the bones. The real support is derived from the muscles, both intrinsic and extrinsic, as may be demonstrated by the fact that the arch may be raised or lowered at will.

The action of the intrinsic muscles is like that of a bow string. They span the arch and draw the anterior and posterior pillars toward each other. The action of the extrinsic muscles is more definitely supportive. The tibialis anticus exerts a direct elevating pull on the apex of the arch. The tibialis posticus passes down behind the internal malleolus and is inserted into the scaphoid, and then spreads out across the foot, tending to sling the arch. The peroneus longus has almost the same function, but in a reversed direction, passing across the bottom of the foot from the outside and being attached to the internal cuneiform and first metatarsal bones. The flexor longus hallucis is another strong muscle with direct supportive function. As it extends forward to the great toe from behind the internal malleolus, it passes directly beneath the sustentaculum tali, which serves as a pulley to change the direction of the tendon. With the great toe fixed as in weight bearing, contraction of this muscle elevates the sustentaculum and supports the arch. The other muscles of the foot have also a supportive function but are relatively of less importance. (See Fig. 9.)

Etiology of Foot Strain.—As has been pointed out by Osgood and Brown, none of the muscles of the foot has a simple action. While their function may be supportive when the foot is supinated, the action may be distinctly reversed when the foot is pronated. Supination raises the arch, while pronation tends to flatten it. In a general way, therefore, the supinating muscles may be regarded as the benevolent or supportive group, and the pronators as the malevolent or destructive group. Preservation of normal foot balance is dependent upon the supinating muscles being stronger than the pronating group. When the strength of these muscles is measured, the normal ratio is found to be as 5:4, in favor of the supinators. In weak feet the balance is even, and in conditions of foot strain the ratio is usually reversed.

The height of the arch has, however, no special significance in relation to foot strain, as it varies normally with

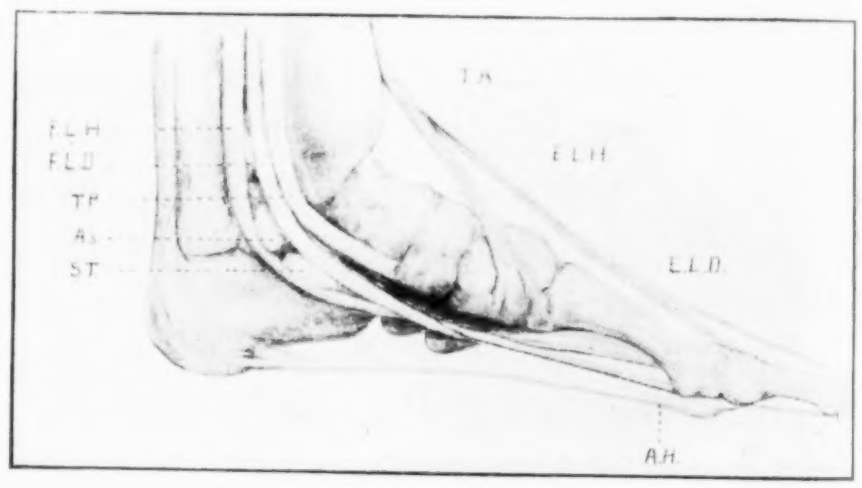

FIG. 9.—Mesial aspect of foot showing arrangement of tendons. Note the course of the flexor longus hallucis. F.L.H.=flexor longus hallucis; F.L.D.=flexor longus digitorum; T.P.=tibialis posticus; As.=astragalus; T.A.=tibialis anticus; E.L.H.=extensor longus hallucis; E.L.D.=extensor longus digitorum; A.H.=adductor hallucis.

different types of individuals. The slender type of body is usually associated with a slender, high-arched foot, while with the heavy type of body the arch is normally low and the foot broad. In the former a slight degree of strain may prove exceedingly painful, whereas in the latter the foot may be perfectly strong with normal muscle balance and yet the arch may be so low as barely to escape contact with the ground.

Nevertheless, relaxation of the foot with flattening of the arch is commonly associated with foot strain. When the normal muscular support weakens, the strain falls on the ligaments, but these being plastic structures stretch, and deformity follows. The foot pronates and the os calcis rotates outward. The head of the astragalus pitches downward and inward, exerting a direct thrust on the calcaneoscaphoid ligament and forming an abnormal prominence. At first the deformity may be correctible, but with time the ligaments become tightened in their new position and actual bony changes may occur. The forepart of the foot is abducted, owing to the pushing downward and forward of the head of the astragalus. The inner border of the foot, instead of remaining straight, becomes convex, motion is limited, and correction of the deformity becomes impossible.

Although it is possible anatomically to differentiate between the anterior and the longitudinal arches, from the physiological standpoint such distinction is purely artificial. They are so closely interrelated in the function of weight bearing that relaxation in one is certain to be associated with weakening of the other. From the clinical standpoint, however, this distinction is helpful as symptoms may appear more prominently in one than in the other.

The causes of foot strain as usually given are multitudinous and include such things as sudden increase in body weight, change from a sitting to a standing occupation, or conditions of a general nature, such as long illness, general debility, inactivity, and all other factors which may result either in overuse and fatigue of the muscles, or in weakening of the muscles and loss of normal tone. Of far greater importance, however, are the effects of improper shoeing and faulty use of the body.

Improper shoes may lead to foot strain in several different ways. Pointed shoes crowd the toes and disturb the balance of the anterior arch. High heels transfer the entire thrust of the body weight to the forefoot and lead to relaxation of the anterior arch and weakening of the general supportive mechanism. Most shoes are too short for the feet they contain, and in weight bearing the normal spring of the longitudinal arch is prevented. The foot must expand in some manner and, since the toe cap prevents expansion from taking place in the forward direction, it occurs transversely with flattening and broadening of the anterior arch. This interferes with the proper functioning of the foot, weakening it to such an extent that strain may sooner or later occur.

Faulty use of the body weakens the foot by neglect of the normal weight-bearing mechanism. The foot is designed for use when the body is in the erect posture. In this position the weight of the body is transmitted to the apex of the arch with a perpendicular thrust which permits its even distribution between the heel and the forefoot. Balance is easily maintained by normal muscular tone and the work is evenly divided among the various muscles. In positions of faulty posture, however, this is not the case. The weight falls more heavily on the heels, and certain of the muscles are relaxed while others carry more than their fair share of the load. The overworked muscles become fatigued and lose their tone, while those which are not sufficiently used atrophy. The inevitable result is weakening of the foot, disturbance of muscle balance, and ultimate strain.

Faulty gait is included under the same general heading. The primitive gait is one in which the foot is pointed directly forward. In this position, not only are the extrinsic and intrinsic muscles of the foot utilized to the best advantage but considerable additional support is obtained from the short external rotating muscles of the hip which, when the foot is fixed on the ground, as in weight bearing, exert a distinct supinating effect. It is a matter of common observation that the usual gait of most people is one with the toes pointing outward. In this position no support is derived from the hip muscles, and as the foot is used it is habitually pronated.

Diagnosis.—In the differentiation of various conditions affecting the feet, it is as necessary to obtain a careful history as in any more general complaint. Special inquiry should be directed toward the various causes which have already been mentioned. The examination should include inspection in the standing and walking positions, with especial reference to posture, general musculature, and gait. Presence or absence of pronation should be noted, and the posterior aspect of the heels observed for outward rotation of the os calcis. Abduction of the forefoot, broadening of the anterior arch, and hallux valgus may be readily perceived. The presence or absence of congestion, swelling, abnormally free perspiration, etc., are also important. Corns denote boot pressure, and search should be made on the plantar surface for callosities, the sign of abnormal weight bearing. The shoes should also be examined to see whether their lines are good or bad. Bulging of the anterior portion usually indicates bad fitting, while the presence of worn-over edges at the heels gives an indication of the usual tread.

Examination of the feet should include a careful search for points of tenderness, with especial reference to the attachments of the calcaneoscaphoid and plantar ligaments and the under surfaces of the metatarsal heads. All motions of the foot, including dorsiflexion and plantar flexion, supination and pronation, adduction and abduction, and motions of the toes, should be tested. Painful or limited movements should be analyzed from the standpoint of the joint involved and of the structures surrounding that joint.

Considerable help may be obtained by determining the strength ratio of the supinating and the pronating muscle groups. This may be readily measured by a spring balance, one end being fastened to the forefoot and the other to a flat wooden support on which the heel rests. During the test the knee should be supported by the hands to prevent rotation of the femur and use of the hip muscles. (See Fig. 10.)

The various types of foot strain to be differentiated are the following:

1. Acute foot strain.
2. Metatarsalgia.
3. Chronic foot strain.
   - *a.* Chronic strain with only slight pronation.
   - *b.* Chronic strain with pronation but no rigidity.
   - *c.* Rigid flat foot.

Acute Foot Strain.—This condition occurs either as the result of trauma or as an acute giving way of the supporting structures of the foot from excessive use or unaccustomed activity. It may develop suddenly or may follow prodromal symptoms which have been disregarded.

The chief symptom is severe pain localized over the mesial and posterior plantar aspects of the feet, and radiat-

ing up the legs to the knees. The pain is constant but is much increased by weight bearing. Walking is difficult and limping occurs.

Examination shows little or no pronation, and the feet may appear quite normal save for moderate congestion. There is no restriction of motion but supination and pronation may be slightly painful. There is marked tenderness on pressure over a rather large area under the forward portion of the os calcis extending to the mesial surface, and this tenderness may be accompanied by slight swelling.

Metatarsalgia.—This condition is due to relaxation of the anterior arch with strain of the supporting ligaments and painful pressure on bones which normally should not bear weight. The complaint is always of pain under the ball of the foot. On examination the forefoot is found to be flattened transversely and broadened. The toes appear

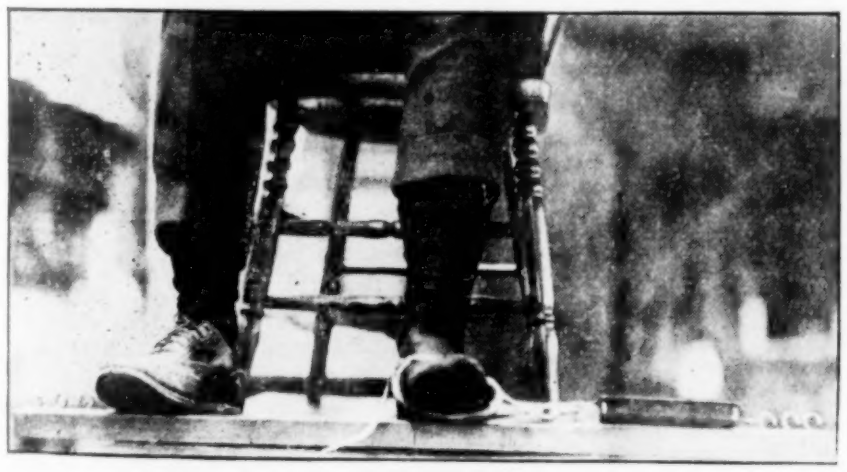

FIG. 10.—Determination of relative strength of supinating and pronating muscles. Measuring the strength of the supinators.

crowded together, and the great toe deviates outward instead of pointing straight ahead. Callosities can usually be found on the plantar surface under the middle of the transverse arch, and pressure on the heads of the second, third, and fourth metatarsals from the plantar surface is painful.

"Morton's toe" is a special form of metatarsalgia. The complaint is classical and consists of intermittent attacks of severe pain localized at the base of the fourth toe. The attacks come on without assignable cause, usually while the person is walking along the street, and the pain is so severe that the shoe must be removed immediately and the toe manipulated in order to obtain relief. The cause has never been completely established, but the condition is always associated with relaxation of the anterior arch, and in certain positions it is probable that a digital branch of the plantar nerve is compressed between the adjacent metatarsals.

Chronic Foot Strain.—The symptoms are subacute and appear gradually. There is at first a feeling of excessive fatigue in the feet and inability to stand without constantly shifting the weight first to one foot and then to the other. Gradually the feet become definitely painful, the pain being noticed chiefly during the day when one is standing or walking, or in the evening following a day of severe exertion. The pain is distributed rather indefinitely to the feet and legs. On examination different degrees of the condition may be differentiated.

a. In the first stage, there is only slight pronation and all movements may be performed without pain or limitation. The only positive signs are alteration of the normal muscle balance, revealed by measurement with the spring balance, and slight tenderness on pressure under the calcaneoscaphoid ligament.

b. In the second stage, there is well-marked pronation of the feet but no limitation of motion.

c. In the third stage, there is not only marked pronation, but definite limitation of movement as well. The feet may be almost rigid, owing to the con-

traction of ligaments and muscles, or there may be true ankylosis resulting from an arthritis. In other cases the limitation may apply only to certain movements, the others remaining free. In this case the rigidity is due to muscle spasm involving either the peroneal or gastrocnemius muscle groups. The latter occurs quite frequently in persons accustomed to wearing high heels, and is of itself an important factor in the production of foot strain.

Back and Foot Strain Considered Jointly

From what has been said under the separate consideration of back and foot strain, it has been seen that faulty body mechanics is the essential factor in the production of both. In the former, the mechanical derangement is one of posture; in the latter, it is not only a question of posture but in addition one of gait and interference with foot function by improper shoes.

It is evident, therefore, that the two conditions are closely related. Whether the symptoms first appear in the spine or in the feet, depends chiefly upon where the greatest strain falls and also upon the individual's point of least resistance. The two conditions may be present at the same time, and it is often difficult to determine whether the case is primarily one of back strain or foot strain. The practical import of this is that in some instances foot symptoms may be secondary to back strain, while in others a complaint of backache may be relieved by treatment of the feet.

The fundamental law of body mechanics is that a line dropped through the center of gravity must fall within the base of support. This is essential to the upright position. If any portion of the skeleton lies in front of the center of gravity, it must be counterpoised by a compensatory projection behind the line to keep the center of gravity over the base of support as represented by the feet. In the normal erect posture with the head back, chest up, abdomen in, and the spinal curves relatively flat, a line dropped from the atloido-occipital joint, the highest joint in the body, should fall perpendicularly through the astragaloscaphoid articulation, the apex of the longitudinal arch. When this occurs, the body is in the position of greatest stability.

When this position is altered by sagging of the body at any point, compensation is obtained by a corresponding change at some other point. The skeleton possesses immense resources for compensation in this way, and thus faulty body mechanics may be supported for a long time without actual damage. The more the reserve compensatory power is diminished, however, the nearer the appearance of symptoms of strain. The ability to compensate varies with each individual and seems to be dependent upon the skeleton structure, and it is in this connection that variations in anatomic structure seem so important.

Prevention

For the last few years at several universities all the members of the entering classes have been systematically examined and an attempt made to group them according to whether their body mechanics were (A) very good; (B) good; (C) poor; or (D) very poor. (See Fig. 11.) Those falling in groups C and D have been selected for treatment by corrective exercises and demonstration of the proper use of the body. It has been found surprisingly easy, in a large number of these cases, to correct

bad habits of many years' standing, so that individuals have been brought from group D to C or even to B.

Prevention of back and foot strain among industrial workers resolves itself into the introduction of a similar procedure. Certainly much can be said in favor of such a plan, and the advantages in the way of better general health, increased efficiency, and decreased disability would probably more than offset any objections which might be raised. It should at least be possible to make a beginning by application of the procedure to all new employees. An element of compulsion is advantageous and should consist of placing individuals with poor body mechanics on probation for a certain period, holding regular employment and full pay as the prizes to reward good work and correction of faulty statics.

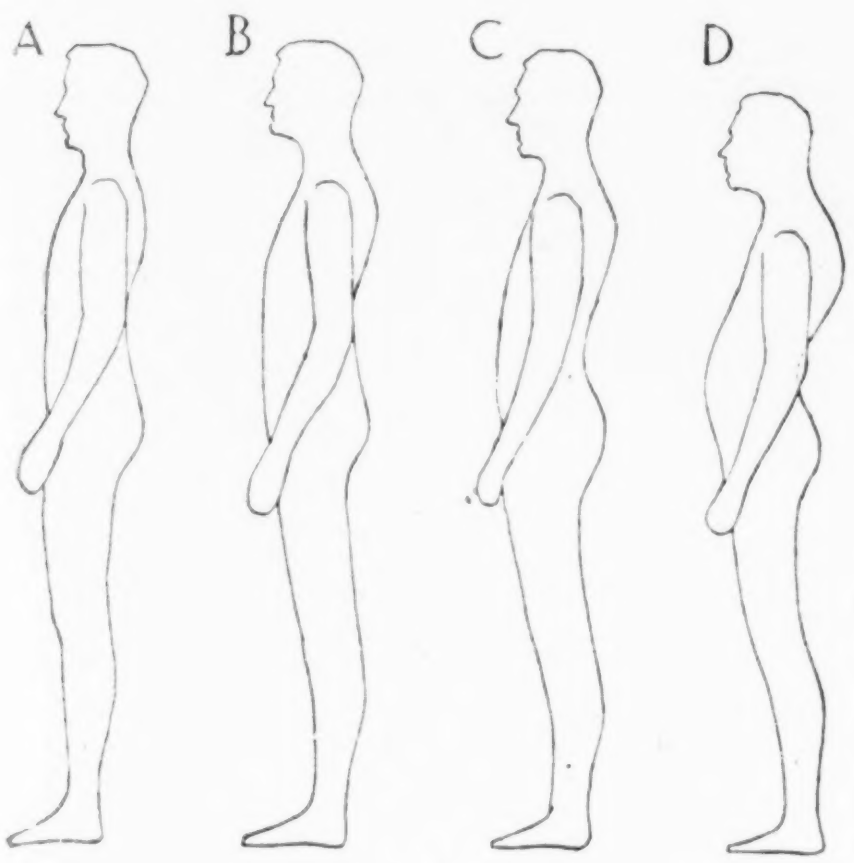

FIG. 11.—Tracings made during examination of 700 Harvard Freshmen.

Group A.—7.5%. Good mechanical use of the human body: (1) head straight above chest, hips and feet; (2) chest up and forward; (3) abdomen in or flat; (4) back, usual curves not exaggerated.

Group B.—12.5%. Fairly good mechanical use of the human body. Note changes from Group A: (1) head too far forward; (2) chest not so well up or forward; (3) abdomen, very little change; (4) back, very little change.

Group C.—55%. Bad mechanical use of the human body. Note changes from Group A: (1) head forward of chest; (2) chest flat; (3) abdomen relaxed and forward; (4) back curves exaggerated.

Group D.—25%. Very bad mechanical use of the human body. Note changes from Group A: (1) head still farther forward; (2) chest still flatter and farther back; (3) abdomen completely relaxed—"slouchy"; (4) back, all curves exaggerated to the extreme.

TREATMENT

Treatment of the various lesions that have been outlined is again fundamentally a matter of correcting faulty body mechanics. The conditions here are different, however, because we are dealing with ligaments that are already strained and muscles that are fatigued. The immediate institution of corrective exercises is no more logical than whipping a tired horse to make him trot.

The first and immediate requirement is rest. Complete rest of the affected structure can only be obtained by recumbency in bed with the removal of gravity as a deforming influence. This is necessary in the severe cases and advantageous even in the mild cases, in that it hastens recovery. When complete recumbency is inadvisable or unnecessary, the injured structures should be rested by the application of some type of brace which removes the strain and secures relaxation of the ligaments.

In the case of back strain this requirement is met by the application of a simple type of brace which spans the exaggerated lumbar curve against which the lower spine may be flattened by means of a belt encircling the pelvis and exerting an upward lift on the abdomen. (Figs. 12 and 13.) The application of a tight adhesive strapping across the back of the pelvis gives relief in certain cases, particularly those with sacro-iliac strain. In cases of

acute traumatic sprain the strapping should extend well above the pelvis and be placed in such a manner as to limit the function of the injured muscles or ligaments. Frequent rest periods through the day, even though of short duration, are important. Hot fomentations applied along the length of the spine twice a day are helpful in producing local congestion and stimulating repair.

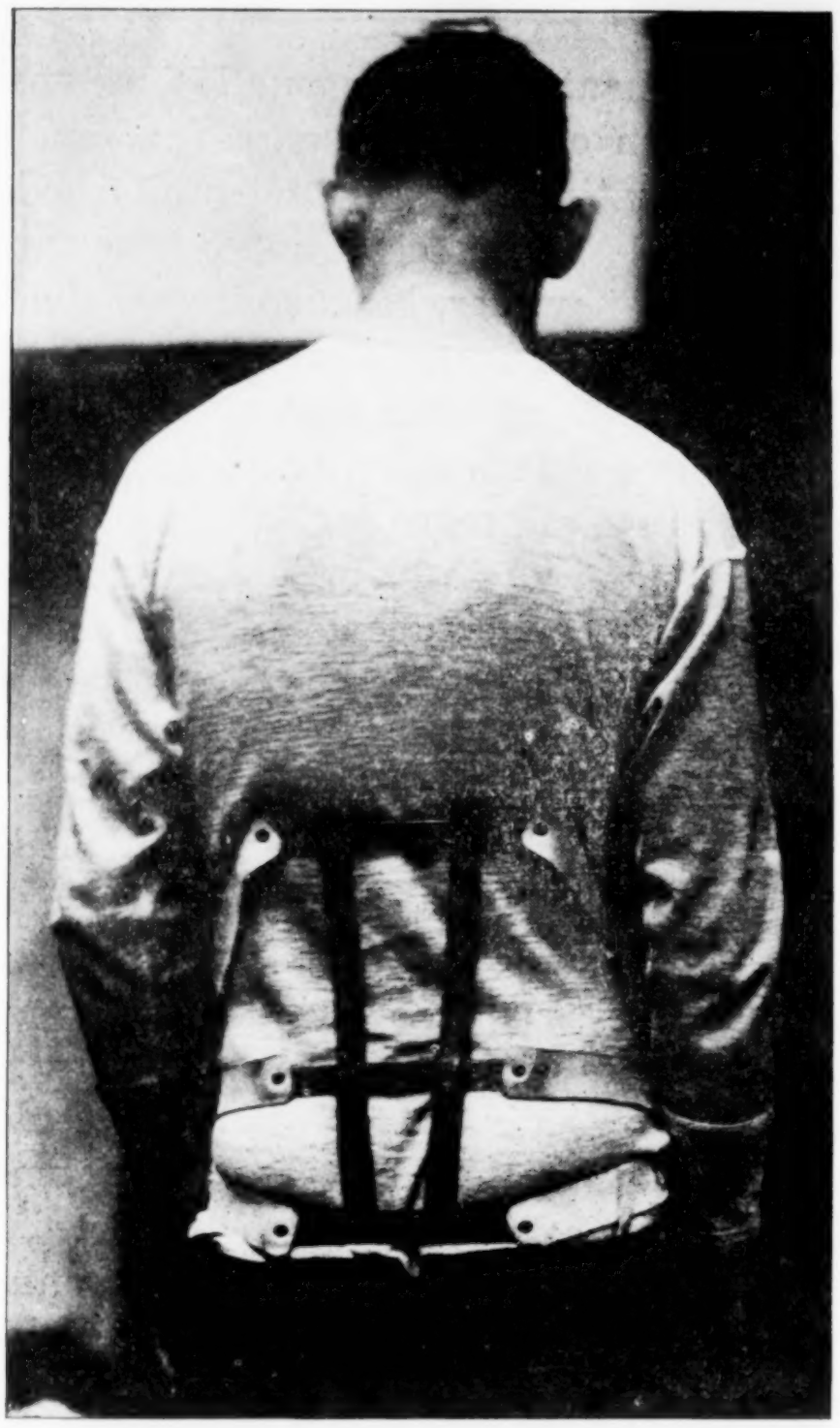

Fig. 12.—Short back brace used in case of back strain.

In the case of foot strain one of the first steps should be the replacement of improper footwear by shoes of good line and ample size. Rest and relaxation of the strained structures may be obtained by different types of braces or dressings. The longitudinal arch may be padded with felt and retained by a stirrup strapping of adhesive which holds the foot well supinated. (Fig. 14.) The anterior arch may be similarly supported by an encircling band of adhesive with felt pads placed beneath the metatarsals. More permanent support may be obtained by the use of Thomas' heels, the inner border being raised ¼ inch and extended forward ½ to ¾ inch. (See Fig. 15.) Painful pressure on the metatarsal heads may be relieved by nailing a strip of leather 1 inch wide and ¼ inch thick obliquely across the sole just behind the tender area. This is illustrated in Figure 16.

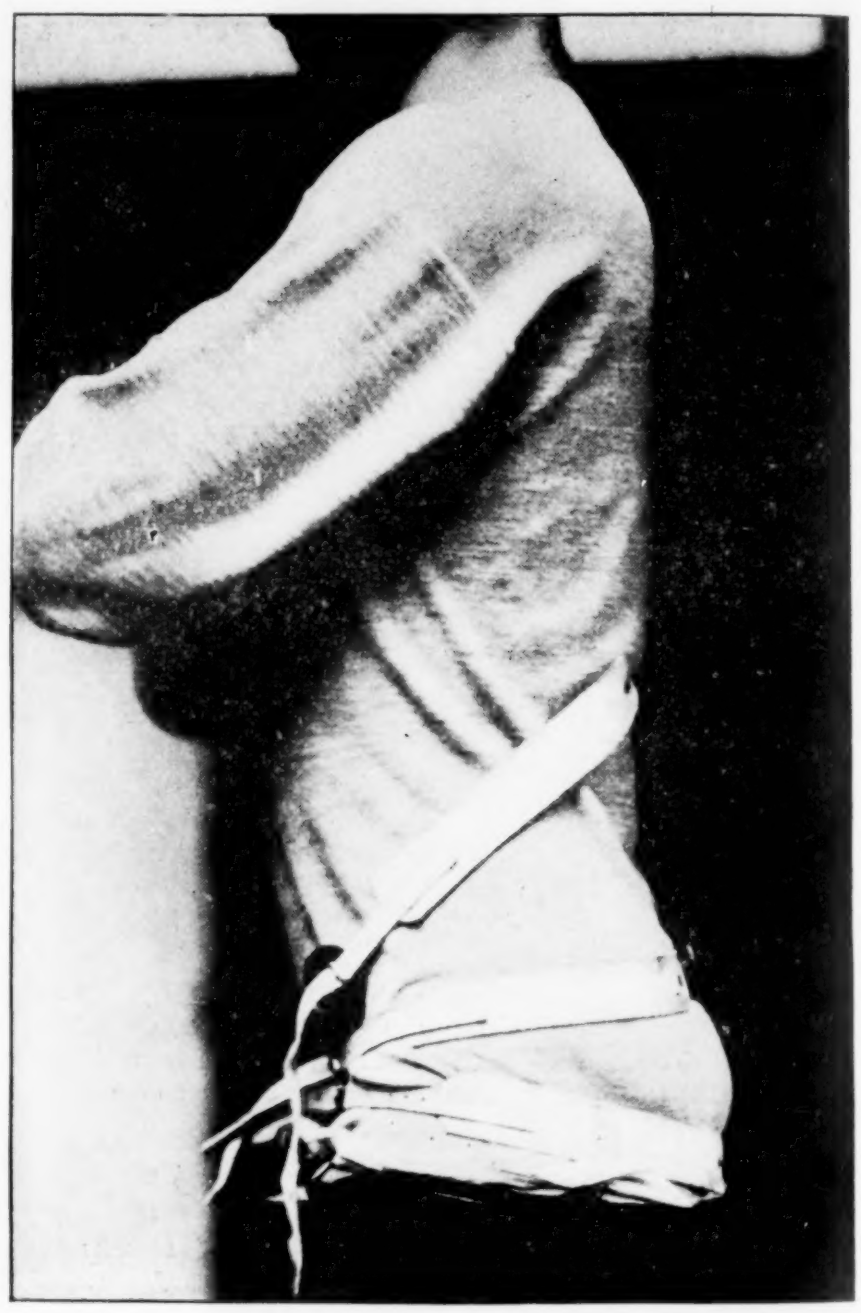

Fig. 13.—Lateral view of back brace.

FIG. 14.—Adhesive strapping for foot strain. Foot strapped in inversion.

In mild cases sufficient support may be obtained for the longitudinal arch by the use of a figure 8 leather ankle strap, or for the anterior arch by a laced leather foot cuff. (See Figs. 17 and 18.) The use of foot plates is more difficult and in only a small percentage of the cases are they necessary. Stock plates of different sizes, types of which are shown in Figure 19, may be kept on hand or plaster impressions of the feet may be taken from which special supports can be made. Alternating hot and cold contrast baths are helpful in

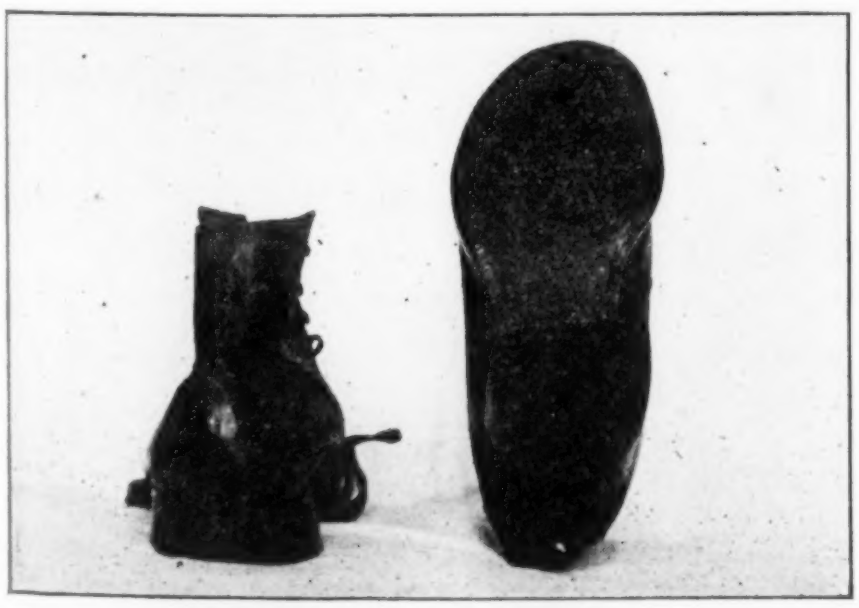

FIG. 15.—Thomas' heels. Inner border raised ¼ inch and extended forward ½ inch.

FIG. 16.—Metatarsal bar ¼ inch thick extending across sole just behind the heads of the metatarsals.

improving the circulation, and the feet should be kept elevated as much as possible.

In both the back and foot cases after a sufficient period of rest, as shown by the subsidence of the painful symptoms, corrective postural training should be begun. Not only should the essentials of good posture be demonstrated but the patient should be shown in a mirror in what respects his own body mechanics are bad. He must be taught how to flatten the spine and pull himself erect. The abdominal muscles must be strengthened and he must learn to ro-

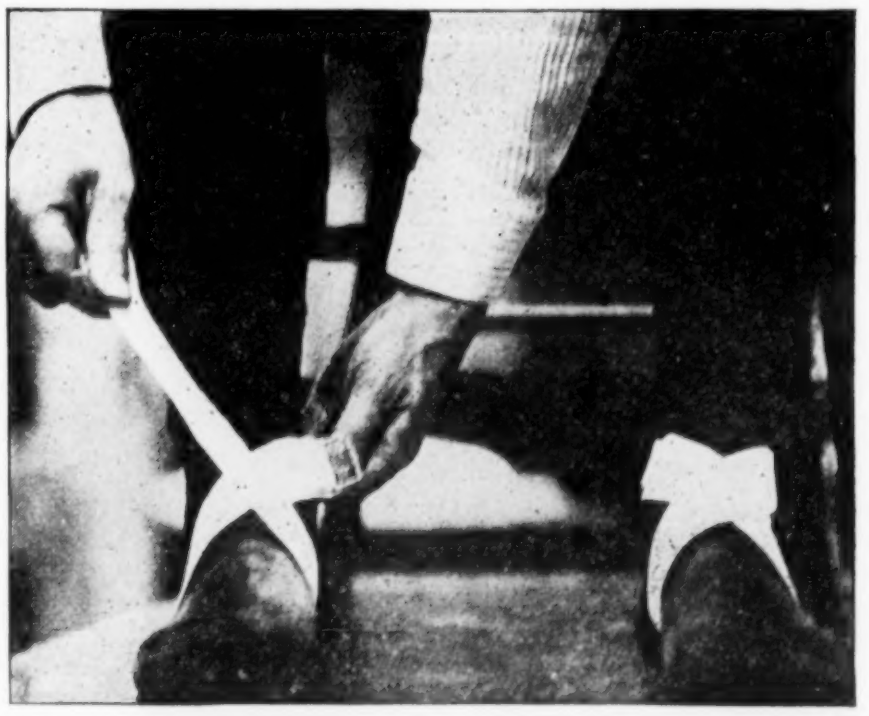

FIG. 17.—Figure 8 ankle straps for support of weak feet.

tate the pelvis, in order to decrease its inclination, and to hold the chest elevated and breathe with the diaphragm.

In cases of foot strain, in addition to

FIG. 18.—Anterior arch cuffs for relief of metatarsalgia.

postural training, emphasis should be placed on the correction of improper gait by toeing straight ahead or slightly inward, thus using the extrinsic leg muscles to support the arches. Special exercises, such as picking up marbles with the toes, are helpful in strengthening the supinator muscles and toe flexors.

Last to be considered are the cases of rigid flatfoot. The problem here is

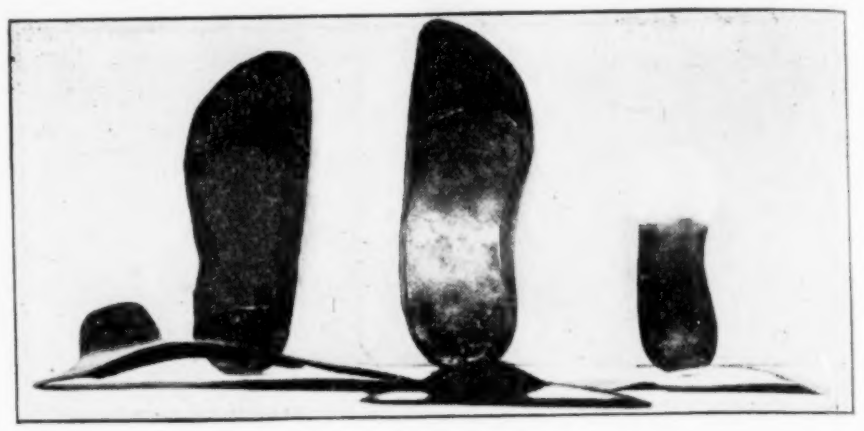

FIG. 19.—Different types of arch supports required for extreme cases.

to restore flexibility. The contracted tendo achillis may be stretched out by proper exercises. Peroneal spasm may require manipulation or open operation. Ankylosed feet require open operation with simple osteotomy or removal of a wedge of bone to restore the normal lines of weight bearing.

OCCUPATIONAL SICKNESS: A REVIEW*

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Introduction

THE increasing interest taken in the study of such questions as hours of labor, rest pauses, ventilation, and lighting, has compelled more and more recognition of the fact that unhygienic conditions in factory or workshop must sooner or later result in reduced vitality, which in its turn produces lessened output with consequent financial loss to both employer and employed. Conversely, it may be said that where reduced vitality is found to exist it is caused by some unhygienic condition. Thus, reduced vitality becomes a finger post pointing the direction to further research.

Hence some attempt should be made to obtain a measure of it in various industries. In England and Wales the Registrar General's Occupational Mortality Returns are generally used for this purpose. For instance in 1910 to 1912 (the last available data), while the comparative mortality among males for the whole country, from all causes, was 790, that among stone-getters and masons was 1,427, among cutlers and scissor-makers 1,285, among potters and earthenware-makers 1,196. The reduced vitality shown in these three industries is due mainly to unhygienic conditions conducing to the inhalation of dust and producing a special form of phthisis.

As is well known, several causes combine to make these official mortality returns unsatisfactory. They are published only at intervals of ten years. They refer only to the occupation in which a man is believed to have been engaged at the time of death. Reduced vitality may not always lead directly to death, and impairment of health not infrequently leads to change of occupation; with the result that the death is credited to the secondary occupation and not to that which has actually produced it. Moreover, the effect of any change in industrial conditions takes long to show itself in mortality, while the conditions of an industry may themselves be undergoing rapid change, as in the case of the boot and shoe trade—a trade which has been completely revolutionized within the last quarter of a century.

Sickness affords a more satisfactory measure. It not only makes its effect felt much more quickly, but generally occurs while the victim is at his occupation, to which he usually returns again when sufficiently recovered.

Previous Investigations

American.—The value of investigations into the occupational incidence of sickness is being more and more realized both in Great Britain, and on the Continent, and in the United States. In the United States two interesting attempts have been made recently to obtain information as to occupational sickness.

1. Between 1915 and 1920 the Metropolitan Life Insurance Company of New York published ten treatises on the subject, of which the last, under

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TABLE 1.—RATES OF ATTACK AND OF SICKNESS AMONG INDUSTRIAL WORKERS IN ALL OCCUPATIONS, LEIPZIG, 1887-1905[1]

Cause	No. of Attacks per Annum among 100 Persons in Each Age Group										Weeks of Sickness per Annum among 100 Persons in Each Age Group									
	Males					Females					Males					Females				
	15-24	25-34	35-44	45-54	55-64	15-24	25-34	35-44	45-54	55-64	15-24	25-34	35-44	45-54	55-64	15-24	25-34	35-44	45-54	55-64
Influenza	2.11	2.93	3.48	3.79	4.28	2.10	3.60	5.07	5.61	4.91	3.7	6.1	8.3	10.7	14.5	4.6	9.2	14.4	16.6	19.8
Phthisis and tuberculosis	0.55	0.82	1.03	1.01	0.90	0.53	0.83	0.85	0.78	0.58	6.3	9.1	12.4	11.9	11.0	6.0	10.0	10.3	8.3	6.5
Rheumatism	2.10	3.59	5.63	7.49	8.59	1.23	2.49	4.77	6.37	6.75	4.6	9.2	16.2	24.5	34.9	3.6	8.0	16.4	24.7	29.2
Diseases of respiratory system	4.70	5.20	6.08	7.79	11.18	3.87	5.93	7.16	7.45	9.02	14.1	19.0	24.0	35.2	60.3	14.5	26.8	31.7	33.7	42.9
Diseases of circulatory system	1.39	1.10	1.13	1.43	1.88	8.59	7.69	5.78	3.87	2.67	5.1	4.2	5.2	7.5	13.1	31.7	31.5	27.7	18.7	17.5
Diseases of digestive system	5.86	6.12	5.72	6.10	7.05	8.19	9.83	10.08	10.12	8.18	10.1	12.9	14.3	17.9	25.0	18.9	27.8	32.6	30.7	27.1
Diseases of nervous system	0.74	1.24	1.93	2.40	2.66	1.03	1.89	2.55	2.62	1.66	2.7	5.6	10.1	13.2	16.9	4.1	8.1	12.0	12.9	9.1
Diseases of skin	4.36	3.14	3.49	3.85	4.07	2.72	2.83	3.60	4.58	4.16	7.9	6.8	9.3	13.1	17.6	6.4	8.8	13.9	20.4	21.2
Other causes	4.86	4.48	4.27	4.88	5.62	5.91	7.91	7.44	6.36	5.10	14.7	14.5	15.9	22.1	31.1	21.5	33.9	33.2	33.2	28.4
Total	26.67	28.62	32.76	38.74	46.23	34.17	43.00	47.30	47.76	43.03	69.2	87.4	115.7	156.1	224.4	111.3	164.1	192.2	199.2	201.7
Accidents	9.74	8.15	9.48	9.95	9.83	2.76	2.59	3.06	3.87	4.72	21.7	20.3	27.4	33.9	38.1	7.1	7.9	10.0	13.7	18.0

[1]Illness due to accidents and the puerperal state is excluded.

TABLE 4.—DAYS OF SICKNESS PER ANNUM AMONG WORKERS IN THE IRON AND STEEL INDUSTRY FROM VARIOUS CAUSES DURING THE YEARS 1913-1918[1]

Male Lives

Occupation	Rheumatism				Respiratory Diseases				Compensated Injuries				All Other Sickness and Injuries				All Causes			
	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69
Steel melters, teemers and pitmen	0.3	1.0	1.6	2.3	1.6	1.9	2.5	3.9	1.0	1.2	1.4	1.4	2.7	2.5	4.8	4.2	5.6	6.6	10.3	11.8
Puddlers	0.6	0.9	1.7	3.1	1.0	1.7	3.4	4.1	0.2	0.5	0.8	1.0	0.8	2.2	3.0	4.7	2.6	5.2	8.9	12.9
Tinplate mill men	0.4	0.7	1.4	3.1	1.9	1.9	2.2	3.8	0.7	0.5	0.9	1.4	3.2	3.1	4.3	5.2	6.2	6.2	8.8	13.5
Rolling mill men, soaker men, hot bank men	0.4	0.7	1.5	2.0	1.7	1.8	2.0	3.4	0.6	1.0	1.0	2.3	2.7	2.7	4.0	7.0	5.4	6.2	8.5	14.7
Engine men, crane men, locomotive men	0.3	0.6	0.6	0.8	1.9	1.8	2.8	3.7	0.3	0.5	0.3	0.8	2.6	2.1	3.0	5.8	5.1	5.0	6.7	11.1
All other workers (largely laborers)	0.3	0.7	1.3	1.6	1.6	1.6	2.1	3.6	0.4	0.5	0.7	0.8	2.2	2.5	3.0	4.6	4.5	5.3	7.1	10.6
All workers combined	0.3	0.7	1.3	1.9	1.6	1.7	2.3	3.7	0.5	0.6	0.8	1.0	2.4	2.6	3.5	5.0	4.8	5.6	7.9	11.6

[1]Illness termed "disablement" in the National Health Insurance Acts and illness due directly to war are excluded.

TABLE 2.—WEEKS OF SICKNESS PER ANNUM AMONG 100 PERSONS IN EACH AGE GROUP SHOWN BY VARIOUS INVESTIGATIONS INTO THE GENERAL EXPERIENCE OF FRIENDLY SOCIETIES

Male Lives

Investigation	Ages 20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
Ansell, 1823-1827	78.5	82.5	89.3	100.9	119.5	147.5	189.0	258.6	399.1
Neison:									
England and Wales, 1836-1840	85.7	89.0	91.7	103.6	127.3	163.4	218.0	304.9	474.6
Scotland, 1831-1842	87.7	86.6	79.9	90.0	105.0	139.2	218.4	291.9	450.6
Finlaison, 1846-1850									
England and Wales	98.1	98.4	98.1	108.4	122.7	143.7	177.3	219.6	308.0
Light Labor:									
(*a*) Without exposure to weather.	88.6	86.4	84.6	95.4	105.1	126.7	167.4	208.7	284.9
(*b*) With exposure to weather	84.0	84.4	80.1	93.6	104.9	117.3	149.7	154.4	191.1
Heavy Labor:									
(*a*) Without exposure to weather.	98.3	98.1	102.3	108.7	123.9	151.1	197.9	248.0	320.4
(*b*) With exposure to weather	104.3	108.3	110.3	122.0	141.7	163.1	187.0	237.0	361.9
Sutton:									
England, 1856-1860	91.2	89.5	91.8	106.5	129.0	165.3	213.5	322.8	495.8
England, 1861-1870	97.2	97.5	105.7	115.3	135.7	167.4	222.1	321.3	500.8
Wales, 1856-1875	104.5	106.7	109.5	122.7	147.5	183.5	225.7	291.7	526.5
England and Wales, 1876-1880	85.5	87.3	102.3	124.0	146.8	188.9	239.3	336.5	517.3

TABLE 3.—WEEKS OF SICKNESS PER ANNUM AMONG 100 PERSONS IN EACH AGE GROUP SHOWN BY VARIOUS INVESTIGATIONS INTO THE MANCHESTER UNITY FRIENDLY SOCIETY'S EXPERIENCE

Male Lives

Investigation	Ages 20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
1846-1848	67.8	75.8	83.7	94.0	117.0	151.5	203.0	320.6	505.9
1856-1860	82.9	82.0	85.8	100.4	123.9	154.5	201.1	302.5	463.8
1866-1870	75.4	80.6	92.8	106.2	126.1	163.6	222.2	304.7	471.5
1893-1897									
Whole Society	89.7	95.5	106.4	126.5	158.0	198.6	274.6	402.5	630.7
A. H. J. Agricultural and General	82.1	87.0	96.6	113.8	144.3	181.1	253.9	376.2	585.0
B. C. D. Outdoor (building, railway, seafaring, etc.)	95.2	99.8	117.2	144.9	174.5	230.2	314.3	457.4	716.6
E. F. (Quarry, iron, steel, chemical, etc.)	119.6	129.7	145.7	166.3	212.4	256.5	316.2	500.1	828.1
G. Mining	146.0	165.9	182.6	225.5	269.6	344.8	484.8	646.0	1093.1
C. Railway servants	116.5	115.2	121.5	158.8	175.3	201.3	277.0	394.0	793.2

Most of the investigations make some attempt at analyzing sickness in broad groups of occupation. For instance, as shown in Table 3, the Manchester Unity, 1893-1897, gives sickness rates by age groups in respect to the following general classes of workers: (1) agricultural and general; (2) outdoor (building, railway, seafaring, etc.); (3) quarry, iron, steel, chemical, etc.; (4) mining; (5) railway servants. The results of these investigations tend to show that next to age, which has the most effect, occupation

is the most important factor in determining the amount of sickness, and that while locality and density of population may probably have a minor effect, it cannot generally be dissociated from that due to occupation. But in none of the investigations has any attempt been made to analyze sickness into its various causes. Generally speaking, the records kept did not give the information required for this purpose, and in the few instances where the facts were given they were in such a form that their compilation would have involved an inordinate amount of time and expense. Another great defect in these returns is that there are none of any value referring to female lives, so that it may be said that up to the present time no reliable statistics of sickness among female lives have been published in the United Kingdom. Neither are there any general sickness statistics for the country corresponding to those which the Registrar General publishes for mortality.

The reason for this unsatisfactory state of affairs is not far to seek—namely, that hitherto sickness statistics in this country have been viewed mainly from the financial standpoint—that is, in their bearing upon the relations between contributions payable and benefits receivable in the operations of Friendly Societies.

Recent Investigations in Great Britain

With regard to the public health, sickness statistics of a more or less general character are available as to epidemics, sanitation and similar matters; but with regard to the effect of conditions of occupation no detailed figures have been published, though their importance was indicated long ago by both Neison and Finlaison.

The introduction of the National Health Insurance scheme into Great Britain nearly ten years ago suggests a possible fruitful field of exploration. The medical certificates required before payment of sick benefit give the causes of illness, and these are recorded in the registers or on record cards, so that it is within the bounds of possibility to analyze them statistically. The diagnoses may not always be as accurate as might be desired, but experience already gained in their treatment tends to show that the records may be used in broad groups with sufficient precision. Only in comparatively few instances does it seem probable that the disease recorded on the certificate fell very widely outside the general group of illness to which it naturally belongs.

The causes of death given in much detail by the Registrar General in the decennial returns of occupational mortality are open to almost as much objection upon other points, but nobody would suggest that they should therefore be ignored in investigations into the effect of occupation upon mortality.

A question arises, however, as to how the records for particular trades can be isolated with sufficient accuracy for comparative purposes. Under the National Health Insurance Acts, the occupation is stated only at entry into a society, and in the great majority of cases no subsequent changes of occupation are noted. Moreover, a member once entering an approved society cannot be turned out because he has entered upon a different trade. He has, however, the power within certain limitations to transfer from one society to another; and, in the case of societies dealing with particular trades, the members do as a matter of fact transfer if there is available a similar trade

society dealing with the new occupation upon which they are entering.

Hence in societies with membership restricted to a particular trade, mainly of the "trade union" order, comparatively little error would be caused by treating all members as belonging to a particular trade. On this assumption the Industrial Fatigue Research Board has made a tentative start upon the iron and steel industry, foundry workers, the boot and shoe trade, and others. The results for the first named industry were published in 1920 in a very interesting report entitled "Fatigue and Efficiency in the Iron and Steel Industry" (10).

Iron and Steel Industry.—An analysis of the data was made in six groups of occupations: (1) steel smelters, teemers and pitmen; (2) puddlers; (3) tinplate mill men; (4) rolling-mill men, etc.; (5) engine, crane and locomotive men; and (6) other workers. Rates of sickness were obtained in age groups for rheumatism, respiratory diseases, injuries, and other causes, respectively. The total number of years of life observed was no less than 112,887, involving 972,932 days of sickness. It was found that the first two groups showed, for all causes and ages combined, rates of sickness over 20 per cent. above the average for the whole industry. This excess was largely made up of illness from rheumatism. Especially was this the case among the puddlers, who had an excess of 78 per cent. above the average from this cause. They also had an excess of 35 per cent. from respiratory diseases. This was probably due to the custom followed by many puddlers of alternating periods of extremely hard work, generally of about twenty minutes' duration, with periods of similar length during which they rest or do light work. The steel smelters and pitmen owed some of their excess also to these two causes, but even more to injuries (especially burns in the pitmen). Their heavy work comes in occasional bursts, alternating with long periods of comparative rest. They not infrequently change their shirts after a bout of heavy work, and are often provided with shelters into which they can retire, while puddlers, as a general rule, have no such protection. (Table 4.) An investigation was also made into the records of sickness of a body of blast furnace men at Middlesborough, which produced much the same result—an excess of sickness from rheumatism and respiratory diseases. This was most marked among the barrow fillers and laborers, and would seem to be due to exposure to the weather. It was more marked than among the melters, puddlers and tinplate mill men, who carry on their occupation at high temperatures. These blast furnace men were living in a single area of the country so that it would not do to be too dogmatic but it would appear that work at normal temperatures in the open is more likely to cause rheumatism and respiratory diseases than work at high temperatures. The result of this investigation is therefore highly instructive, and gives some idea of the value of research of this kind into the incidence of occupational sickness.

Boot and Shoe Trade.—The other inquiries referred to are not yet complete, but for the boot and shoe trade some figures are available in regard to female lives which are particularly interesting, both because they afford some up-to-date information about a subject on which little is known, and because they differentiate between married and single women. The figures available agree with the common opin-

ion that women lose more days through sickness than do men. They bring out the interesting fact that, even omitting illnesses due to the puerperal state, married women up to middle age have a higher sickness rate from all causes combined than single women. The full explanation of this is not yet apparent, but doubtless it is partly due to the fact that home circumstances give married women greater inducement to prolong the period of sickness. Another interesting result was obtained by the division of the lasters and makers, finishers and clickers into "service" and "non-service" men. The service men were those who at any time had been on active service during the War, and as they were medically selected for war service, the non-service men might have been expected to show a higher sickness rate, as being less fit. But the facts obtained showed that in each of the three sub-occupations, the service men had the heavier rates of sickness, except in the age group 25-34. This apparent anomaly arose from the fact that the period for which the men were on active service was necessarily omitted from the analysis; hence a considerable number of men were included in the tabulation who through wounds or illness had become unfit for active service and returned to their ordinary occupation in a subnormal physical condition. Table 5 gives the rates of attack and sickness by age groups, for all causes combined. Space limitations forbidding the setting out here of the rates for each group of causes, Table 6 is given in which a useful device has been adopted, by means of which some idea can be obtained of their relative weight. This is the application of the method employed by the Registrar General for comparative occupational mortality returns. For this purpose the population is taken as distributed according to age in the following proportions:

TABLE 5.—SICKNESS IN VARIOUS OCCUPATIONS DURING THE YEARS 1915-1919: RATES OF ATTACK AND SICKNESS FROM ALL CAUSES COMBINED[1]

Occupation	No. of Attacks per Annum among 100 Members in Each Age Group				Weeks of Sickness per Annum among 100 Members in Each Age Group			
	16-24	25-34	35-44	45-54	16-24	25-34	35-44	45-54
Males								
Boot and Shoe Trade:								
(*a*) Service men								
Lasters and makers	35.41	28.09	30.71	41.99	107.5	98.5	137.7	250.5
Finishers	37.89	28.98	29.63	43.90	107.2	108.8	130.8	222.5
Clickers	34.12	26.25	26.63	41.49	99.5	104.8	104.1	117.7
(*b*) Non-service men								
Lasters and makers	33.22	30.56	24.92	26.28	108.9	114.7	87.7	101.9
Finishers	36.39	32.36	25.07	23.94	128.2	129.0	96.5	92.0
Clickers	30.32	33.81	24.06	22.46	110.2	133.2	89.0	81.5
Females								
Spinsters and widows:								
Boot and shoe trade	36.05	28.20	23.75	29.89	128.9	118.6	100.3	131.7
Laundry workers	17.80	19.55	16.25	31.10	72.7	86.2	92.5	167.8
Married women:								
Boot and shoe trade	39.41	31.82	30.36	35.74	164.0	133.3	143.5	139.4
Laundry workers	20.26	22.68	24.40	28.51	104.7	122.9	170.9	195.7

[1]Illness termed "disablement" in the National Health Insurance Acts, accidents, illness due directly to war, and diseases relating to the puerperal state are excluded.

TABLE 6.—SICKNESS FROM VARIOUS CAUSES IN STANDARD POPULATION BETWEEN THE AGES OF 16 AND 54 DURING THE YEARS 1915-1919 IN BOOT AND SHOE AND LAUNDRY TRADES[1]

Occupation	Number of Attacks per Annum										Weeks of Sickness per Annum									
	All Causes	Influenza	Phthisis and Tuberculosis	Rheumatism	Respiratory Diseases	Circulatory Diseases	Digestive Diseases	Nervous Diseases	Skin Diseases	Other Causes	All Causes	Influenza	Phthisis and Tuberculosis	Rheumatism	Respiratory Diseases	Circulatory Diseases	Digestive Diseases	Nervous Diseases	Skin Diseases	Other Causes
Males																				
Boot and shoe trade:																				
(*a*) Service men																				
Lasters and makers	302	63	11	28	47	17	55	19	32	30	1,222	155	127	113	228	92	189	104	97	117
Finishers	312	65	11	35	46	18	57	20	31	29	1,192	161	103	158	188	73	203	84	87	135
Clickers	284	66	16	19	40	9	56	24	27	27	950	157	109	58	131	53	148	117	75	102
(*b*) Non-service men																				
Lasters and makers	267	77	13	24	42	13	41	11	25	21	946	198	125	79	163	55	123	44	75	84
Finishers	277	63	15	25	48	16	43	13	28	26	1,044	176	128	81	181	71	152	65	89	101
Clickers	259	80	16	18	47	12	32	12	19	23	971	210	155	57	183	51	112	52	55	96
Females																				
Spinsters and widows:																				
Boot and shoe trade	271	73	5	13	33	22	59	19	21	26	1,086	225	42	49	147	112	227	85	78	121
Laundry workers	182	40	6	14	32	16	24	9	13	28	873	123	55	92	130	88	121	45	49	170
Married women:																				
Boot and shoe trade	314	71	5	18	46	27	76	23	18	30	1,325	246	38	94	197	134	294	108	65	149
Laundry workers	211	39	4	23	30	25	29	10	11	40	1,265	212	27	151	180	160	167	79	46	243

[1]Illness termed "disablement" in the National Health Insurance Acts, accidents, illness due directly to war, and diseases relating to the puerperal state are excluded. The standard population is one-hundredth of that used by the Registrar General.

ages 16-24, 29,054; 25-34, 26,259; 35-44, 20,407; 45-54, 14,748. For convenience one-hundredth of these figures has been taken as the standard population in Table 6.

Recommendation

This brief statement of what has been attempted shows how promising is the field of research indicated. The interests of the health of the industrial community demand that a systematic attempt be made to obtain the facts relating to the incidence of occupational sickness. To measure the results of such investigations, standard tables of sickness are periodically required in which age groups and sex are distinguished. The records accumulating in the large general "approved" societies under the National Health Insurance Acts with membership running into hundreds of thousands, or even millions, of lives would furnish such a standard fairly representative of the industrial population of the country. It is the more to be regretted, therefore, that the exigencies of national finance have compelled the postponement of some and the abandonment of other of the trade sickness investigations contemplated by the Industrial Fatigue Research Board.

It is evident that little further help can be expected from government sources even for such a promising inquiry. Representatives of both employers and employed must interest themselves in the utility of such investigations which bear so closely upon both the efficiency and the comfort of the worker, by the creation of joint bodies charged with research into the general question of the human element in their respective trades, of which sickness incidence forms by no means an inconsiderable part. As the *Lancet* has recently pointed out, "The health of its people is the first care of every industry; this assured, other profits will follow."

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BOOK REVIEWS

HEALTH SERVICE IN INDUSTRY. By *W. Irving Clark, Jr.*, M.D., F.A.C.S., Service Director, Norton Company, Worcester, Mass.; Lecturer on Health Administration in Industry, Harvard Medical School; Assistant Surgeon, Memorial Hospital, Worcester, Mass. Cloth. Pp. 168. New York: The Macmillan Company, 1922.

Dr. Clark has presented in this book his conception of methods for the proper organization of an industrial medical department and its auxiliary services. It is the fruit of many years of experience in the administration of a notably well conducted industrial medical department.

Eleven chapters of about fifteen pages each deal with such questions as medical organization in large and small factories; factory dispensaries; industrial medical personnel; physical examinations; accidents and their treatment; industrial morbidity; and factory sanitation. Each subject is considered briefly but with precision. There are many useful tables of equipment and suggestive graphs. As stated in the preface, the author has not attempted to discuss more than one approved method of doing a thing.

Brief and simple, written essentially for industrial executives or physicians entering industrial practice, it is a much needed and excellent contribution to the literature of industrial hygiene.—*Wade Wright.*

THE PREVENTION AND RELIEF OF HEART DISEASES. By *G. A. Stephens.* Pp. 91. London: A. H. Stockwell, 1921.

The author of this little book takes cardiac disease as a text from which to speak of the value and importance of medical supervision in industry. He is a physician busy in the important industrial center of Swansea, and his book bears evidence of a running pen and of hurried proof correction. Notably on page 43 figures appear which can only puzzle the reader until he perceives that they are printer's errors; while on page 49 the population of Great Britain is stated as 20,000,000 instead of 47,000,000. These minor details should, however, be overlooked in view of the good work done in drawing attention to the extent and importance to national economy of the problem of heart disease; to the fact that many so-called "heart cases," which are now relegated to the industrial dust heap, are capable of productivity if fitted with suitable occupation; and to the need for employers to co-operate in rehabilitating such cases, and so benefit themselves, the workmen and the nation at large.

Dr. Stephens speaks highly of the work set on foot in America by the Association for the Prevention and Relief of Heart Disease, especially with regard to trade schools for cardiac convalescents; he calls for similar effort to be undertaken in Great Britain. He is insistent that cases of impaired cardiac capacity need, not idleness, but activity within their capacity, and that occupational therapy, properly controlled, is the most valuable of remedies; while "from a national point of view it must be worse than useless if we prolong the life of drones rather than re-create units of useful productive capacity."—*E. L. Collis.*

PREVENTION OF MALARIA IN THE FEDERATED MALAY STATES. By *Malcolm Watson.* London: John Murray, 1921.

This book, which is a record of twenty

years' progress in the prevention of malaria, is one of great interest to those whose work lies in tropical areas. The author brings out clearly how every district presents its own peculiar problems in this matter. Incidentally, he draws attention to the importance of health from an industrial point of view, particularly with relation to wastage of a labor force. The Malay estates are worked chiefly with native labor attracted from abroad, especially from India, and Dr. Watson states that "while coolies remain on an average three years on the healthier estates, they remain only two years on the unhealthy estates." This extra year on the healthy estates means an increase of the labor force by 50 per cent., and more than a 50 per cent. increase in the work done; for the coolie, at the end of his two years, is a skilled workman, especially when he is tapping rubber. Malaria is, therefore, an economic factor of great importance. We have here an excellent example of a fact which is often maintained, namely, that wastage of labor has a very definite relationship to health.—*E. L. Collis.*

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

LEHRBUCH DER GRENZGEBIETE DER MEDIZIN UND ZAHNHEILKUNDE FÜR STUDIERENDE, ZAHNÄRZTE UND ÄRZTE. By Prof. Dr. O. Büttner; Prof. Dr. G. Finder; Prof. Dr. E. Fuld; Prof. Dr. F. Grossmann; Prof. Dr. A. Gutmann; Dr. E. Herzfeld; Ministerialrat Obermedizinalrat Dr. F. Kölsch; Geh. San.-Rat Dr. H. Kron; San.-Rat Dr. R. Ledermann; Dr. J. Misch; Dr. H. Mühsam; Dr. G. Tugendreich. Edited by Dr. *Julius Misch.* Paper. Vol. I, pp. 691, with index, introduction, and illustrations. Vol. II, pp. 672, with index, introduction, and illustrations. Leipzig: F. C. W. Vogel, 1922.

OPIATE ADDICTION: ITS HANDLING AND TREATMENT. By *Edward Huntington Williams*, M.D., formerly Associate Professor of Pathology, State University of Iowa; Associate Editor of the Ency. Brit. (Tenth Edition); Assistant Physician, New York State Hosp. System; Special Lecturer on Criminology and Mental Hygiene, State University of California; Author of "Mental Hygiene," "The Walled City: A Story of the Criminal Insane," "The Question of Alcohol," etc. Cloth. Pp. 194, with index and introduction. New York: The Macmillan Company, 1922.